MUZEUL OLTENIEI CRAIOVA

OLTENIA
STUDII ȘI COMUNICĂRI ȘTIINȚELE NATURII

Vol. XXVII/2

CRAIOVA 2011

OLTENIA

STUDII ŞI COMUNICĂRI ŞTIINŢELE NATURII

Oltenia Journal for Studies in Natural Sciences

Tom. XXVII, No. 2 / 2011

MUZEUL OLTENIEI CRAIOVA

Oltenia. Studii şi comunicări. Ştiinţele Naturii

ISSN 1454 – 6914

2011, Tom. 27, no. 2

Cover Image: *The Building of the Section of Sciences of Nature of the Museum of Oltenia Craiova*

Editor in Chief: **Cornelia CHIMIŞLIU** - Craiova, Romania

Asociate Editor's

Aurelian POPESCU
Craiova, Romania
Gima LILA
Craiova, Romania
Olivia CIOBOIU
Craiova, Romania
Claudia Ionelia GOGA
Craiova, Romania

Managing Editor:
Istvan SAS
Oradea, Romania

Tehnical Editor:
Daniela POPESCU
Craiova, Romania

Language Editor:
Alina VLĂDUŢ
Craiova, Romania

Editorial Board:

Ionel ANDRIESCU Iaşi, Romania	**Alexander DERUNKOV** Minsk, Belarus	**Gheorghe MUSTAŢĂ** Iaşi, Romania
Marcel BENEA Cluj-Napoca, Romania	**Pascal GODEFROIT** Bruxelles, Belgique	**Constantin PISICĂ** Iaşi, Romania
Gheorghe BREZEANU Bucureşti, Romania	**Marian Traian GOMOIU** Constanţa, Romania	**Ştefan NEGREA** Bucureşti, Romania
Gülşah ÇOBANOĞLU Istanbul, Turkey	**Eugen GRĂDINARU** Bucureşti, Romania	**Zenovia OLTEANU** Iaşi, Romania
Vlad CODREA Cluj-Napoca, Romania	**Nicolae HAR** Cluj-Napoca, Romania	**Călin RICMAN** Bucureşti, Romania
Doina CODREANU-BĂLCESCU Bucureşti, Romania	**Stanilă IAMANDEI** Bucureşti, Romania	**Zbyšek ŠUSTEK** Bratislava, Slovakia
Gabriel CORNEANU Craiova, Romania	**Ivan ILIEV** Sofia, Bulgaria	**Emanoil ŞTIUCĂ** Bucureşti, Romania
Mihaela CORNEANU Timişoara, Romania	**Lăcrămioara IVĂNESCU** Iaşi, Romania	**Victoria TATOLE** Bucureşti, Romania
Mihai COSTICĂ Iaşi, Romania	**Ciprian MÂNZU** Iaşi, Romania	**Constantin TOMA** Iaşi, Romania
Severus-Daniel COVACIU-MARCOV Oradea, Romania	**Dan MUNTEANU** Cluj-Napoca, Romania	**Maria-Magdalena ZAMFIRACHE** Iaşi, Romania
Valeriu DERJANSCHI Chişinău, Republic of Moldova	**Dumitru MURARIU** Bucureşti, Romania	**Mircea VARVARA** Iaşi, Romania

Journal coverage:
- Zoological Record (by Thomson Reuters, former ISI)
- CNCSIS (The National University Research Council, Romania) – **„B+" category**

Available On-line:
Oltenia. Studii şi comunicări. Ştiinţele Naturii with full text articles available on-line: http://www.olteniastudii.3x.ro/

Publisher: Museum of Oltenia Craiova, Str. Popa Şapcă, no. 8 – 200 422, Craiova, Romania
Financial Support by: The Council of Dolj County, Romania

CONTENTS / CUPRINS

I. VEGETAL BIOLOGY / BIOLOGIE VEGETALĂ

II. ANIMAL BIOLOGY

II. a. ENTOMOLOGY / ENTOMOLOGIE

II.b. VERTEBRATES / VERTEBRATE

III. ECOLOGY- ENVIRONMENTAL PROTECTION / ECOLOGIE – PROTECŢIA MEDIULUI

IV. MINERALOGY-PALEONTOLOGY / MINERALOGIE-PALEONTOLOGIE

V. SCIENTIFIC ESSAYS / REFERATE COMMEMORATIONS / COMEMORĂRI

GENETIC AND BREEDING VALUE OF TOMATO VARIETIES WITHOUT GENICULATE JOINT OF FLORAL PEDUNCLE

MIHNEA Nadejda

Abstract. One of the main problems of modern vegetable farming is the creation of new economically efficient varieties with complex valuable characters adapted to different growing conditions. In tomato breeding, the genotypes that possess the j-2 and j-2^{in} (jointless-2) genes are particularly important, because the fruits of such plants are easier detached from the peduncle and are less deformed during harvesting and transportation. The presence of peduncles causes the decrease of fruit quota and reduction of product quality, conferring them a bitter taste. In order to reveal the variability of agronomical traits and specify the value of tomato genotypes without geniculate joint of floral peduncle, a comparative assessment was carried out based on a range of useful characters. The varieties were evaluated in terms of the most valuable biological parameters (yield, fruit weight, fruit quota, vegetation period, pericarp thickness, cold and draught resistance). Genotypes characterized by both precocity and high productivity were identified in the collection of cultivated tomatoes. The analysis of tomato varieties based on resistance to cold permitted highlighting of highly resistant genotypes, which may be used as initial material for breeding purposes.

Keywords: tomato, breeding, resistance, cold, draught.

Rezumat. Valoarea genetico-ameliorativă a formelor de tomate fără articulaţie geniculată a pedunculului floral. Una din problemele principale ale legumiculturii contemporane este crearea soiurilor cu caractere valoroase complexe, adaptate condiţiilor de creştere şi eficacitate economică. O importanţă deosebită în ameliorarea tomatelor le prezintă formele posesoare ale genelor j-2 şi j-2^{in} (jointless-2), deoarece la aceste genotipuri fructul mai uşor se desprinde de pedicel, nu se deformează la recoltare şi transport. Prezenţa pedicelului duce la diminuarea cotei fructelor marfă şi calităţii produselor de tomate, conferindu-le, totodată, gust amărui. Pentru a demonstra variabilitatea caracterelor agronomice şi a preciza valoarea genotipurilor de tomate fără articulaţie geniculată a penduncului floral, s-a efectuat evaluarea comparativă a genotipurilor de tomate, după un complex de caractere utile. Evaluarea genotipurilor s-a efectuat în baza utilizării celor mai valoroşi parametri biologici (recolta generală şi recolta marfă, masa medie a fructului, cota fructelor marfă, perioada de vegetaţie, masa fructului, grosimea pericarpului, rezistenţa la arşiţă şi frig). În colecţia tomatelor de cultură au fost identificate genotipuri care îmbină însuşirea de precocitate cu productivitatea înaltă. Analiza genotipurilor de tomate în baza rezistenţei la arşiţă şi frig a permis evidenţierea genotipurilor înalt rezistente care prezintă interes ca material iniţial în ameliorare.

Cuvinte cheie: tomate, ameliorare, rezistenţă, frig, arşiţă.

INTRODUCTION

One of the main problems of contemporary vegetable cultivation is the creation of new economically efficient varieties with complex valuable characters adapted to growing conditions. Mechanized technologies, applied for a range of crops: pea, tomato, onion, bean, etc. have led to an increase of labour productivity up to 10 – 20 times, a significant decrease of the products' price, an amplification of the yield, creation of better working conditions for the employees. The use of mechanized technologies within the breeding programs of vegetables (including tomato) requires certain conditions that must be considered by breeders. The newly developed varieties should satisfy the specific constraints of mechanized harvesting, should be productive, with simultaneous fruit ripening to assure a single-time collection, and the fruits should be able to maintain their physical and chemical qualities for a long period of time.

In tomato breeding, the genotypes that possess the J gene are particularly important. The fruits of such plants are easier detached from the peduncle and are less deformed during harvesting and transportation.

The aim of the given research was the study of the productivity, as well as cold and draught resistance of tomato varieties without geniculate joint of floral peduncle.

MATERIAL AND METHODS

28 tomato samples of different geographical origin that are carriers of **j** and **j-2** genes were selected from the collection of the Center for Vegetal Genetic Resources, Institute of Genetics and Plant Physiology, Academy of Sciences of Moldova (Table 1). Culture by seedling and tomato growing technology approved for the Republic of Moldova were used.

The selected varieties were subjected to thermal stress under laboratory conditions with the purpose of distinguishing genetic sources of cold and draught resistance.

Sample resistance to high temperatures was assessed according to methodical recommendations IVAKIN, 1979, based on the growing abilities of embryonic roots after the maintenance at 43°C for 6 hours. The evaluation of tomato varieties in terms of cold (+10°C) resistance was made in accordance with the protocol of Russian Phytotechnical Institute SMIRNOVA & GARANIKO, 1990.

Table 1. Biological material origin.
Tabel 1. Originea materialului biologic.

No.	Genotype name	Origin
1	Breeding Line 325	Canada
2	Ermak	Exp. st. Birucesc (Russia)
3	Kolokolicik	Moldova
4	69 B-243	-
5	H-102	USA
6	Antei	Ukraine (Crimea)
7	Victorina	Moldova
8	Step 1008 (442)- BK-BK	USA
9	L-3000	USA
10	Lebyajenskiy	Exp. st. Volgograd (Russia)
11	Mashinyi adygeiscy	-
12	Campbell 24	Canada
13	Atlacnyi	Kharkov (Ukraine)
14	Myti	Kharkov (Ukraine)
15	Karasi	Kharkov (Ukraine)
16	Maestro	Kharkov (Ukraine)
17	Funtik	Kharkov (Ukraine)
18	Peto 76	USA
19	Planeta	Moldova
20	Evrica	Moldova
21	Izabeli	Moldova
22	Nezabutca	Moldova
23	Amulet (Tм)	Russia
24	Sharm (Tм)	Russia
25	F 249 (Tм)	Armenia
26	Lucezarnyi (Tм)	Kazakhstan
27	Meruert (Tм)	Kazakhstan
28	Samaladai (Tм)	Kazakhstan
st	Youliana	Moldova

RESULTS AND DISCUSSIONS

The main objective of the undertaken research consisted in the elucidation of breeding value of tomato genotypes of different origin. Comparative assessment of specimens selected from a specialized collection allowed to distinguish genetic sources useful for the creation of new lines with complex profitable traits.

Precocity is one of the most valuable traits for tomato varieties, because it permits a longer harvesting period. It was observed that the precocity may be enhanced by crossing the varieties with short interphase periods. For one parent this period is referred to the time between the mass seedling appearance to flowering, while for the second one – from flowering till ripening (MAMEDOV et al., 2002). The cultivated tomato collection is characterized by a significant variability of this trait. Phenological observations made throughout the vegetation period have shown big differences among the developmental phases, depending on the variety and climatic conditions. Based on the vegetation period, tomatoes are classified in: ultra-early (<105 days), early (106-110 days), medium (111-115 days), late (116-120 days) and very late (> 120 days). The studies depicted a large diversity of the varieties in terms of interphase period "mass seedling appearance to flowering" (Table 2). Late flowering was observed at: Myti (86 days), Funtik (83 days), Breeding Line 325 (81 days), Ermak (80 days), Lebyajenskiy (77 days), Atlasnyi, Maestro (76 days), Karasi, Amulet (Tм), F 249 (Tм), Sharm (Tм), Lucezarnyi (Tм), Meruert (Tм) (74 days) Victorina and L-3000 (73 days). In 2008 the mentioned character varied from 58 to 86 days. The analysis of phenotypic variability of interphase period "flowering - ripening" resulted in significant differences among the studied genotypes. A shorter period was observed for Lebyajenskiy (34 days), Mîti (35 days), Step 1008(442)-BK-BK (37 days), Funtik (41 days), Kolokolicik, Antei, Campbell 24, Youliana (43 days). According to existing standards, the analysed varieties can be divided into: ultra-early (69 B-243, H-102, Step 1008(442)-BK-BK, Lebeajenschii, Peto 76, Youliana), early (Campbell 24, Evrica, F 249 (Tм), Nezabutca, Lebyajenskiy), medium (Antei, Planeta), late (Myti, Izabeli, Meruret (Tм)) and very late (Breeding Line 325, Ermak, Victorina, L-3000, Mashinyi adygeisciy, Atlasnyi, Karasi, Maestro, Funtik, Amulet (Tм), Sharm (Tм), Lucezarnyi (Tм), Samaladai (Tм)). Hence, the analysed genotypes may be used as initial breeding material for the creation of new varieties with different vegetation period.

Pericarp thickness is an important parameter that determines the quota of the fruits. Pericarp size and variability should be taking into consideration while creating tomato genotypes intended for mechanical cultivation. GUSEVA, 1989 states that intensive varieties require a pericarp of 0.2 cm and thicker. Data from the specialized literature (BACULINA, 1970; BLAŞCIUC, 1983; MAMEDOV et al., 2002; MIHNEA et al., 2008; MIHNEA, 2008; SMIRNOVA & GARANIKO, 1990) provide evidence for a considerable genotypic variability of the mentioned trait. The studied varieties were assessed in terms of pericarp size and significant differences were ascertained (Fig. 1). According to the existing standards of tomato morphological traits, pericarp can be: thin (< 3 mm), average (3-6 mm), and thick (>6 mm). Based on the comparative analysis of the results, tomato varieties were divided in 3 groups: those with a thick

pericarp (Atlasnîi, Evrica, Amulet (Tм), with a thin one (Myti), and 25 genotypes with middle-sized pericarp. Therefore, along with other valuable characters, the majority of selected varieties are suitable for transportation.

Table 2. Phenotypic variability of interphasic periods in tomato.
Tabel 2. Variabilitatea fenotipică a perioadelor interfazice la tomate.

No.	Genotype name	Appearance of plantlets/flowering, days	Flowering/ripenin, days	Vegetation period, days
1	Breeding Line 325	81	45	125
2	Ermak	80	47	126
3	Kolokolicik	58	43	100
4	69 B-243	62	44	105
5	H-102	62	44	105
6	Antei	69	43	111
7	Victorina	73	54	126
8	Step 1008 (442) - BK-BK	69	37	105
9	L-3000	73	52	124
10	Lebyajenskiy	77	34	110
11	Mashinyi adygeisciy	86	45	125
12	Campbell 24	65	43	107
13	Atlacnyi	76	47	122
14	Myti	86	35	120
15	Karasi	74	50	123
16	Maestro	76	47	122
17	Funtik	83	41	123
18	Peto 76	58	48	105
19	Planeta	58	58	115
20	Evrica	65	43	107
21	Izabeli	63	55	117
22	Nezabutca	63	46	108
23	Amulet (Tм)	74	48	121
24	Sharm(Tм)	74	50	123
25	F 249 (Tм)	63	46	108
26	Lucezarnyi (Tм)	74	49	122
27	Meruert(Tм)	74	47	120
28	Samaladai (Tм)	70	53	122
st	Youliana	63	43	105

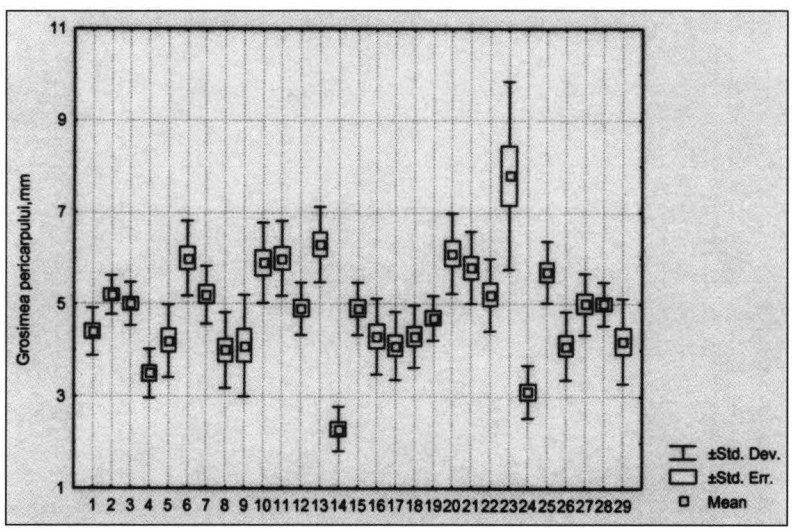


Figure 1. Comparative analysis of tomato varieties based on pericarp thickness.
Figura 1. Caracteristica comparativă a soiurilor de tomate în baza grosimii pericarpului.

Legend: 1. Breeding Line 325; 2. Ermak; 3. Kolokolicik; 4. 69 B-243; 5. H-102; 6. Antei; 7. Victorina; 8. Step 1008 (442) - BK-BK; 9. L-3000; 10. Lebyajenskiy; 11. Mashinyi adygeisciy; 12. Campbell 24; 13. Atlacnyi; 14. Myti; 15. Karasi; 16. Maestro; 17. Funtik; 18. Peto 76; 19. Planeta; 20. Evrica; 21. Izabeli; 22. Nezabutca; 23. Amulet (Tм); 24. Sharm (Tм); 25. F 249 (Tм); 26. Lucezarnyi (Tм); 27. Meruert (Tм); 28. Samaladai (Tм); 29. Youliana.

Fruit weight is one of the main traits that determine the direction of tomato breeding programs. Based on this parameter, the examined varieties were grouped as follows: with big fruits (>100 g) – Breeding Line 325, Ermak, Atlasnyi; average fruits (51-100 g) – Antei, Victorina. Step 1008 (442)- BK-BK, L-3000, Lebyajenskiy, Mashinyi adygeisciy, Campbell 24, Karasi, Peto 76, Evrica, Izabeli, Amulet (Tм), F 249 (Tм), Meruret (Tм), Samaladai (Tм), Youliana and with small fruits (<50g) – Kolokolcik, 69 B-243, H-102, Myti, Maestro, Funtik, Planeta, Sharm (Tм).

Although the absolute weight of the fruits varies within each population, according to the assessment results, the biggest mass was noticed at fruits of Atlasnyi, while the smallest – at H-102 variety (Fig. 2).

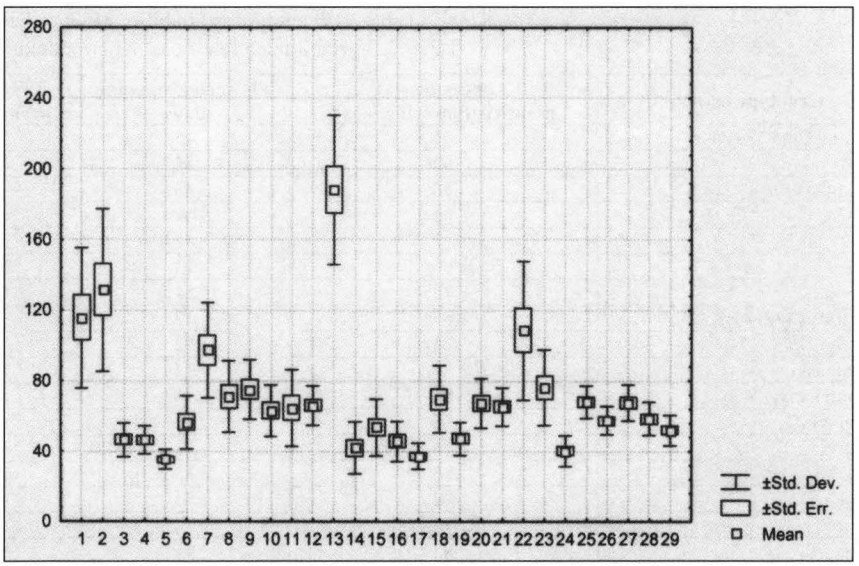


Figure 2. Distribution of tomato varieties based on fruit weight.
Figura 2. Distribuirea soiurilor de tomate în baza mesei fructului.

Legend: 1. Breeding Line 325; 2. Ermak; 3. Kolokolicik; 4. 69 B-243; 5. H-102; 6. Antei; 7. Victorina; 8. Step 1008 (442)- BK-BK; 9. L-3000; 10. Lebyajenskiy; 11. Mashinyi adygeisciy; 12. Campbell 24; 13. Atlacnyi; 14. Myti; 15. Karasi; 16. Maestro; 17. Funtik; 18. Peto 76; 19. Planeta; 20. Evrica, 21. Izabeli; 22. Nezabutca; 23. Amulet (Tм); 24. Sharm (Tм); 25. F 249 (Tм); 26. Lucezarnyi (Tм); 27. Meruert (Tм); 28. Samaladai (Tм); 29. Youliana.

The results of the analysis of genotype productivity, assessed in comparison with the control variety (Iuliana), are presented in figure 3. A large variability, depending on both the genotype and climatic conditions, was established. In 2008, the productivity of the varieties under investigation fluctuated between 11.8 t/ha (Lucezarnyi) and 44.8 t/ha (Maestro). In comparison with the control (the yield of which constituted 31.6 t/ha), an increased productivity was registered for Kolokolicik (35.5 t/ha), H-102 (36.0 t/ha), Myti (37.4 t/ha), Maestro (44.8 t/ha). The yield of the varieties: Breeding Line 325, Ermak, 69 B-243, Victorina, Step 1008 (442)-BK-BK, L-3000, Lebyjenskhiy, Mashinyi adygeisciy, Karasi, Funtik, Peto 76, Izabeli, Nezabudca, Amulet (Tм), Sharm (Tм), F 249 (Tм), Lucezarnyi (Tм), Meruert, Samaladai, was lower than that of the control.

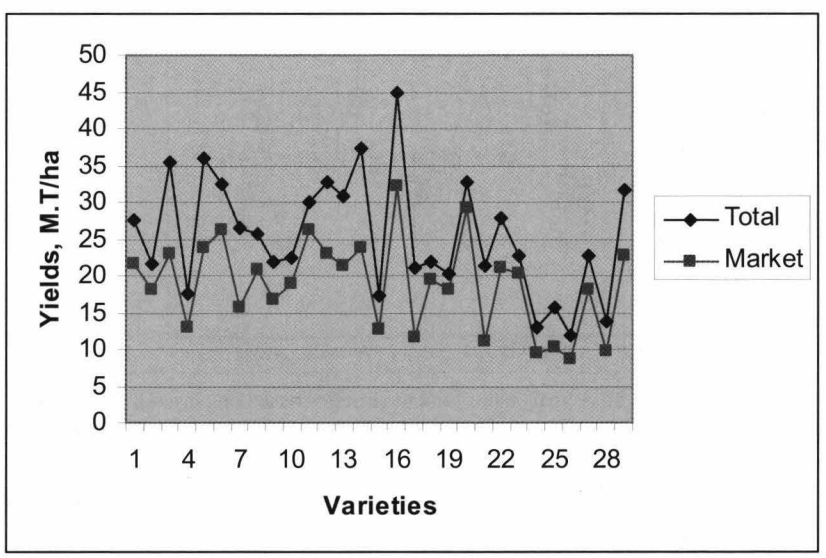


Figure 3. Assessment of the genotypes in terms of productivity.
Figura 3. Evaluarea genotipurilor de tomate în baza productivității.

Legend: 1. Breeding Line 325; 2. Ermak; 3. Kolokolicik; 4. 69 B-243; 5. H-102; 6. Antei; 7. Victorina; 8. Step 1008 (442)-BK-BK; 9. L-3000; 10. Lebyajenskiy; 11. Mashinyi adygeisciy; 12. Campbell 24; 13. Atlacnyi; 14. Myti; 15. Karasi; 16. Maestro; 17. Funtik; 18. Peto 76; 19. Planeta; 20. Evrica; 21. Izabeli; 22. Nezabutca; 23. Amulet (Tм); 24. Sharm (Tм); 25. F 249 (Tм); 26. Lucezarnyi (Tм); 27. Meruert (Tм); 28. Samaladai (Tм); 29. Youliana.

As a result, the analysis of valuable traits have emphasized a large variability in terms of vegetation period, fruit size and other parameters, allowing thus the recommendation of the studied varieties as initial material for hybridization with the aim of developing new valuable genotypes.

The selected varieties were subjected to thermal stress under laboratory conditions with the purpose of distinguishing genetic sources of cold and draught resistance. The assessment data (Fig. 4) highlighted a presence of significant resistance variability from 26.7% to 100.0% for cold and from 24.4% to 88.4% for draught. An increased level of cold resistance was attested at Breeding Line 325, Kolokolcik, Victorina, Step 1008 (442)-BK-BK, L-3000, Lebyajenskiy, Karasi, Evrica, F 249 (Tм), Nezabudca, Samaladai, while Victorina, Campbell 24, Izabeli, Funtik, Mashinyi adygeisciy , F 249 (Tм) have proved to be draught resistant. The varieties that combine both cold and draught resistance are of a special value for breeding. Such varieties are: Victorina, Mashinyi adygeisciy, F 249 (Tм). They might be used for breeding purposes as sources of stress resistance genes.

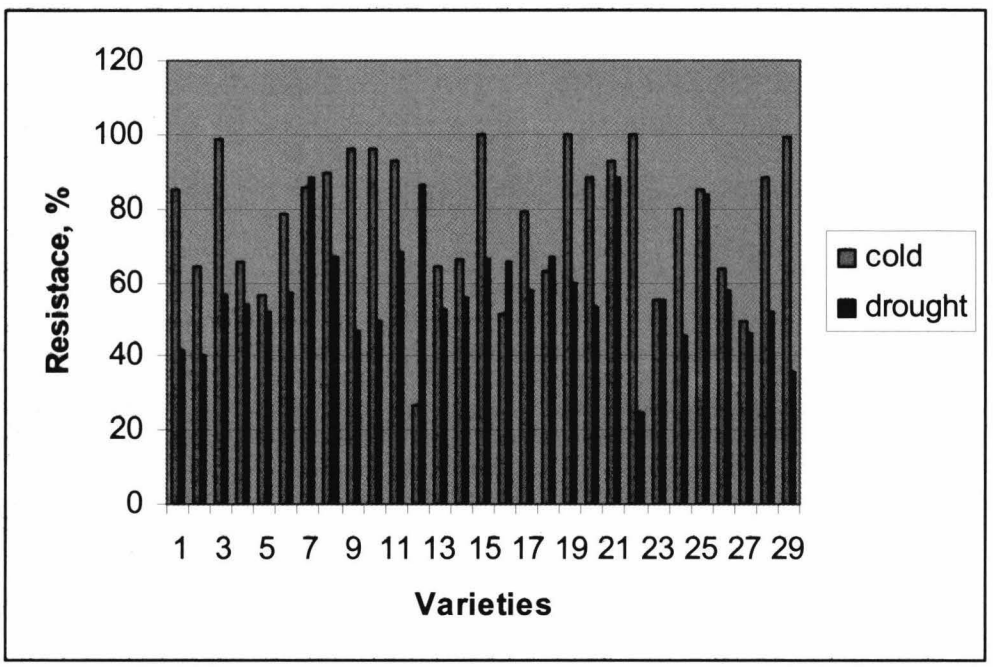


Figure 4. Evaluation of tomato genotypes based on cold and drought resistance.
Figura 4. Evaluarea genotipurilor de tomate după rezistenţa la frig şi arşiţă.

Legend: 1. Breeding Line 325; 2. Ermak; 3. Kolokolicik; 4. 69 B-243; 5. H-102; 6. Antei; 7. Victorina; 8. Step 1008 (442)- BK-BK; 9. L-3000; 10. Lebyajenskiy; 11. Mashinyi adygeisciy; 12. Campbell 24; 13. Atlacnyi; 14. Myti; 15. Karasi; 16. Maestro; 17. Funtik; 18. Peto 76; 19. Planeta; 20. Evrica; 21. Izabeli; 22. Nezabutca; 23. Amulet (Tм); 24. Sharm (Tм); 25. F 249 (Tм); 26. Lucezarnyi (Tм); 27. Meruert (Tм); 28. Samaladai (Tм); 29. Youliana.

CONCLUSIONS

At the Centre for Vegetal Genetic Resources, Institute of Genetics and Plant Physiology, a collection of tomato varieties without geniculate joint of floral peduncle was established. This collection is characterized by a wide variability in terms of vegetation period, fruit weight and other traits, which allows recommending its varieties as initial material for the development of new valuable genotypes.

The varieties: 69 B-243, H-102, Step 1008 (442)-BK-BK, Lebeajenschii, Peto 76, Campbell 24, Evrica, F 249 (Tм), Nezabudca, Lebeajenschii may be used in breeding programs as genetic sources of precocity.

The analysis of tomato varieties without geniculate joint of floral peduncle based on resistance to cold permitted highlighting of highly resistant genotypes: Breeding Line 325, Kolokolcik, Victorina, Step 1008 (442) - BK-BK, L-3000; Lebyajenskiy, Mashinyi adygeisciy, Karasi, Evrica, F 249 (Tм), Nezabudca, Samaladai, which are recommended for the development of new highly productive varieties resistant to low temperatures.

Based on the study of the influence of high temperatures over embryonic roots growth, it was ascertained that the varieties: Victorina, Campbell 24, Izabeli, Funtik, Mashinyi adygeisciy, F 249 (Tм) manifest an increased level of drought resistance.

As a result of the research, Victorina, Mashinyi adygeisciy, F 249 (Tм) were emphasized as being both cold and draught resistant.

REFERENCES

BACULINA V. A. 1970. *Cu privire la unele caractere agronomice valoroase ale fructelor de tomate.* Autoreferatul tezei de doctor în ştiinţe agricole. Moscova. 12 pp. [In Russian].

BLAŞCIUC I. P. 1983. *Aprecierea capacităţii combinative a liniilor de tomate cu markeri genetici.* In: Aspecte genetice şi metodice ale ameliorării plantelor agricole şi animalelor. Naukova dumk. Kiev: 8-10. [In Russian].

GUSEVA L. 1989. *Metode de ameliorare a tomatelor pentru tehnologii intensive.* Edit. Ştiinţa, Chişinău. 222 pp. [In Russian].

IVAKIN A. P. 1979. *Determinarea rezistenţei la arşiţă a culturilor legumicole în baza reacţiei de creştere a plantulelor după menţinerea la temperatură înaltă.* Indicaţii metodice. VIR, Leningrad. 9 pp. [In Russian].

KUZIOMENSCHII A. V. 2004. *Cercetări genetico-ameliorative a formelor mutante de tomate.* Harcov. 391 pp. [In Russian].

MAMEDOV M. I., PIVOVAROV V. F., PÂŞNAIA O. N. 2002. *Ameliorarea adaptabilităţii tomatelor, ardeiului şi vinetelor.* Moscova. 441 pp. [In Russian].

MIHNEA N. I., GANEA A. I., GRATI M. I., IVANCHIV O. V. 2008. *Cercetarea colecţiei tomatelor de cultură în baza caracterelor agronomice valoroase.* In: Problemele bioecologiei şi căile de soluţionare. Materiale ale conferinţei ştiinţifice internaţionale. Saransk: 406-407. [In Russian].

MIHNEA NADEJDA. 2008. *Variabilitatea fenotipică a caracterelor valoroase ale fructului de tomate.* Probleme actuale ale geneticii, fiziologiei şi ameliorării plantelor. Materialele Conferinţei Naţionale cu participare Internaţională. Chişinău: 567-573.

SMIRNOVA V. S. & GARANIKO I. B. 1990. *Diagnosticul rezistenţei la frig a mostrelor tomatelor de cultură.* Indicaţii metodice. VIR, Leningrad. 24 pp. [In Russian].

Mihnea Nadejda
Institute of Genetics and Plant Physiology
Moldovan Academy of Sciences
Str. Pădurii, No. 20, MD-2002-Chişinău
Republica Moldova
E-mail: mihneanadea@yahoo.com

Received: March 29, 2011
Accepted: August 8, 2011

RESEARCH REGARDING THE INTENSITY OF SOME PHYSIOLOGICAL PROCESSES IN *Citrullus lanatus* (THUNB.) MATSUM. & NAKAI IN GRAFTED PLANT CROPS

NICOLAE Ion, LASCU Nicolae, TOMA Vasile

Abstract. Research on the diurnal dynamics of physiological processes was made on watermelon plants (*Citrullus lanatus* (THUNB.) MATSUM. & NAKAI) grafted on *Lagenaria siceraria* (MOLINA) STANDLEY rootstock cultivated on sandy soil, in field conditions, at the CCDCPN, Dăbuleni, Dolj. The review showed that the diurnal dynamics of photosynthesis and transpiration vary depending on weather conditions, presenting minimum values in the morning, maximum values at midday and minimum values towards the evening, with specific variations in the grafted plants, compared with not grafted plants. The linear regressions performed between the photosynthesis rate and the photosynthetic active radiation of Crisby watermelon plants show a positive correlation ($R^2 = 0.88$ in grafted plants and $R^2 = 0.73$ in not grafted plants), while for Rica F1 plants also show a positive correlation ($R^2 = 0.78$ in grafted plants and $R^2 = 0.71$ in not grafted plants). The linear regressions performed between the transpiration rate and the photosynthetic active radiation of Crisby watermelon plants show a positive correlation between them ($R^2 = 0.66$ in grafted plants and $R^2 = 0.95$ in not grafted plants), while for Rica F1 plants also show a positive correlation ($R^2 = 0.67$ in grafted plants and $R^2 = 0.68$ in not grafted plants). The chlorophyll content in mature leaves of grafted plants is lower, between the content of chlorophyll pigments and the photosynthesis intensity being a positive correlation.

Keywords: chlorophyll, physiological processes, photosynthesis, transpiration, watermelon plants.

Rezumat. Cercetări privind intensitatea unor procese fiziologice la *Citrullus lanatus* (THUNB.) MATSUM. & NAKAI în culturi de plante altoite. Cercetările privind dinamica diurnă a proceselor fiziologice s-au efectuat la plantele de pepeni verzi (*Citrullus lanatus* (THUNB.) MATSUM. & NAKAI) altoite pe portaltoiul *Lagenaria siceraria* (MOLINA) STANDLEY, cultivate pe sol nisipos, în condiţii de câmp, la CCDCPN Dăbuleni, Dolj. La plantele analizate s-a constatat că dinamica diurnă a fotosintezei şi transpiraţiei variază în funcţie de condiţiile climatice, prezentând valori minime dimineaţa, valori maxime la prânz şi valori minime spre seară, cu variaţii specifice la plantele altoite, în comparaţie cu plantele nealtoite. Regresiile liniare realizate între rata fotosintezei şi radiaţia fotosintetic activă la plantele de pepeni verzi Crisby evidenţiază o corelaţie pozitivă ($R^2 = 0,88$ la plantele altoite şi $R^2 = 0,73$ la plantele nealtoite), iar la plantele Rica F1 evidenţiază, de asemenea, o corelaţie pozitivă ($R^2 = 0,78$ la plantele altoite şi $R^2 = 0,71$ la plantele nealtoite. Regresiile liniare realizate între rata transpiraţiei şi radiaţia fotosintetic activă la plantele de pepeni verzi Crisby F1 evidenţiază o corelaţie pozitivă ($R^2 = 0,66$ la plantele altoite şi $R^2 = 0,95$ la plantele nealtoite), iar la plantele Rica F1 evidenţiază, de asemenea, o corelaţie pozitivă ($R^2 = 0,67$ la plantele altoite şi $R^2 = 0,68$ la plantele nealtoite). Conţinutul în clorofilă la frunzele mature ale plantelor altoite este mai redus, între conţinutul în pigmenţi clorofilieni şi intensitatea fotosintezei existând o corelaţie pozitivă.

Cuvinte cheie: clorofilă, procese fiziologice, fotosinteză, transpiraţie, plante de pepeni verzi.

INTRODUCTION

The physiological investigations were carried out within the national research program (PN II), No. 52147 / 2008, entitled: "Research on the foundation and development of technology for cultivation of watermelon grafted plants, in order to obtain biological production in sandy soils areas".

The main objective of the project is to develop and promote in the sandy soils of Romania the technologies for obtaining biological watermelons grafted plant crops in order to increase the competitiveness and the profitability of agricultural exploitation.

The research refers to the watermelon culture *C. lanatus* (THUNB. MATSUM. & NAKAI) grafted on *Lagenaria siceraria* (MOLINA) STANDLEY - (Macis F1 hybrid) rootstock, the grafting plants determining an increase of plants resistance to stress factors, high production levels, the elimination of treatments regarding the ground combat pathogens, a better use of organic fertilizers accepted in biological agriculture.

The advantage of grafted plants is to reduce the number of plants used per hectare due to a more vigorous growth, to explore a larger volume of soil due to a very strong root of the rootstock favouring water and nutrient absorption, which leads to a better resistance to heat and water stress.

The watermelon plants grafting techniques have been expanded in recent years to boost plant growth and development, to control wilt caused by pathogens (YETISIR et al., 2003), to increase nutrient and mineral uptake to the shoot (RUIZ et al., 1997), to strengthen tolerance to thermal or saline stress (ROMERO et al., 1997) etc.

The net photosynthetic activity is subjected to seasonal changes and to diurnal changes, which are mainly influenced by the stage of shoot development, the leaf ageing, the accumulation of hormones and of carbohydrates in the leaves, as well as the by the fluctuations of light, leaf temperature, air temperature and humidity (LAKSO, 1985).

Intensity of transpiration process commensurate increases with that of photosynthesis, both processes are dependent on solar radiation intensity (BIGNAMI & NATALI, 1992).

MATERIAL AND METHODS

The physiological investigations were carried out on watermelon plants grown on sandy soil, in 2009, at the Agricultural Station of Research and Development for the Plant Culture on Sandy Soils (CCDCPN), Dăbuleni, Dolj.

The research consisted of analysing physiological watermelon hybrids (Crisby F1, Rica F1) grafted on the Macis F1 hybrid of *Lagenaria siceraria* species, compared with not grafted plants.

Crisby F1 is an extra-early hybrid to Crimson Sweet cultivars type, and Rica F1 is a late hybrid belonging to Sugar Baby cultivars type.

This paper's aim is to study physiological processes (photosynthesis rate, transpiration rate) of watermelon plants in accordance with environmental factors (light, temperature).

The intensity of photosynthesis and transpiration were made by using the portable photosynthesis analyser LCpro+, system which enables automatic recording and other parameters (photosynthetic active radiations, leaf temperature etc.). The obtained results were graphically represented and statistically interpreted.

The content of the chlorophyll pigments was estimates by Minolta SPAD 502 chlorophyll meter (the use of the chlorophyll meter SPAD is non-destructive method and permits repeated measurements).

RESULTS AND DISCUSSIONS

The physiological investigations were carried out on July 7th 2009 and consisted of analysing the diurnal dynamics of some physiological processes (photosynthesis rate, transpiration rate), establishing some correlations between these processes and the intensity of photosynthetic active radiation incident on the leaf surface, as well as establishing the chlorophyll pigments content in grafted plants, in comparison with not grafted plants.

The morphological aspect of grafted and not grafted watermelon plants, in the fruit maturing stage, of the Crisby F1 variety is shown in figures 1; 2, and of the Rica F1 variety is shown in figures 3; 4.

The diurnal dynamics of photosynthesis in the Crisby F1 and the Rica F1 watermelon plants presents low values in the morning due to low light intensity and temperature, and maximum values after lunch due to the growth of light intensity and temperature and of the opening degree of the stomata and low values in the evening due to the gradually decrease in the light intensity and temperature and low opening of the stomata (Figs. 5; 6).

The diurnal dynamics of transpiration in the Crisby F1 and the Rica F1 presents low values in the morning because of the minimum opening of stomata and of the low power of air dehydration, maximum values in the afternoon due to the increasing opening of the stomata according to the growth of the light intensity, temperature and of the power of air dehydration and generally low values in the evening because of the gradual decrease of light intensity and temperature (Figs. 7; 8).

The photosynthetic active radiations have a role in the induction of photosynthesis and transpiration by performing photoactive opening movements of the stomata and by increasing the leaves temperature.

The Crisby F1 watermelon plants have an increasing photosynthetic active radiation in the morning (9 a.m.) when the values are of 1,421 μmol/m^2/s for grafted plants and of 1,228 μmol/m^2/s for not grafted plants, they grow until after noon (1 p.m.) when the values are of 1,681 μmol/m^2/s for grafted plants and of 1,620 μmol/m^2/s for not grafted plants, while towards the evening (5 p.m.) the values decrease gradually to 1,494 μmol/m^2/s for grafted plants and to 1,461 μmol/m^2/s for not grafted plants. The linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.88 for grafted plants and of 0.73 for not grafted plants (Fig. 9).

The Rica F1 watermelon plants have an increasing photosynthetic active radiation in the morning (9 a.m.) when the values are of 1,330 μmol/m^2/s for grafted plants and of 1,589 μmol/m^2/s for not grafted plants, they grow until after noon (1 p.m.) when the values are of 1,609 μmol/m^2/s for grafted plants and of 1,774 μmol/m^2/s for not grafted plants, while towards the evening (5 p.m.) the values decrease gradually to 1,571 μmol/m^2/s for grafted plants and to 1,601 μmol/m^2/s for not grafted plants. The linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.78 for grafted plants and of 0.71 for not grafted plants (Fig. 10).

At the Crisby F1 watermelon plants, the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.66 for grafted plants and of 0.95 for not grafted plants (Fig. 11).

At the Rica F1 watermelon plants, the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.67 for grafted plants and of 0.68 for not grafted plants (Fig. 12).

The temperature, along with the solar radiation intensity, represents the main external factor which influences the processes of photosynthesis and transpiration. The research carried out on the dynamics of air temperature at the time of physiological tests, show an increasing level in the morning (9 a.m.), when the values are of 26°C, an increasing temperature at noon (1 p.m.), when the values are of 30.4°C, and further increasing temperature in the evening (5 p.m.), when the values are of 37°C, after which the temperature begins to decrease gradually.

The chlorophyll content. The mature leaves of grafted plants compared with not grafted plants, show a slight decrease in chlorophyll content of 6.40% for Crisby F1 and of 1.69% for Rica F1 as a result of a gradual deterioration of chlorophyll pigments as leaf growth ceases, and the produced organic substances migrate and accumulate in the fruit (Fig. 13).

Figure 1. *Citrullus lanatus* (Crisby F1) - grafted plants.
Figura 1. *C. lanatus* (Crisby F1) - plante altoite (original).

Figure 2. *Citrullus lanatus* (Crisby F1) - not grafted plants.
Figura 2. *C. lanatus* (Crisby F1) - plante nealtoite (original).

Figure 3. *Citrullus lanatus* (Rica F1) - grafted plants.
Figura 3. *C. lanatus* (Rica F1) - plante altoite (original).

Figure 4. *Citrullus lanatus* (Rica F1) - not grafted plants.
Figura 4. *C. lanatus* (Rica F1) - plante nealtoite (original).

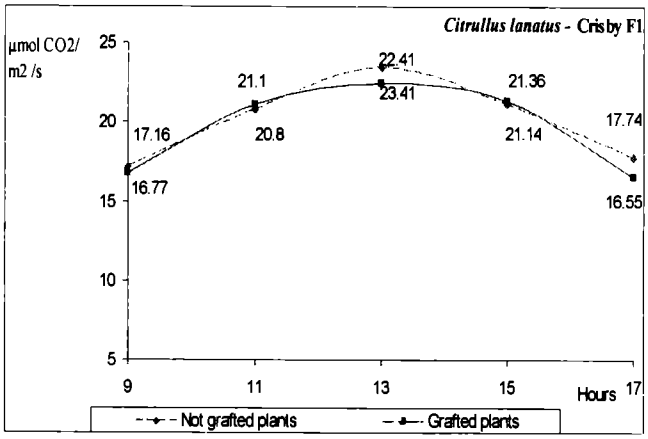


Figure 5. The diurnal dynamics of photosynthesis at the leaves of *Citrullus lanatus* - Crisby F1.

Figura 5. Dinamica diurnă a fotosintezei la frunzele de *C. lanatus* - Crisby F1.

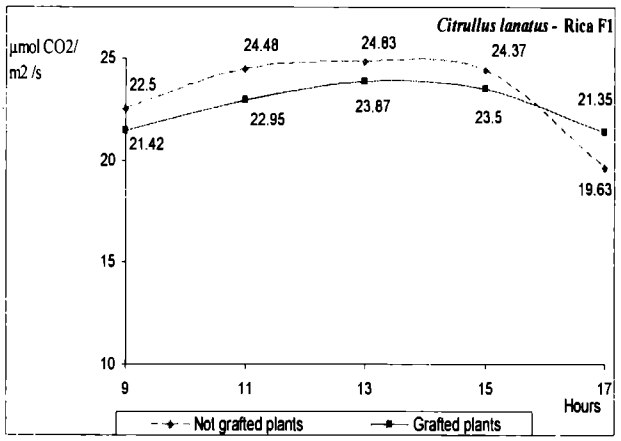


Figure 6. The diurnal dynamics of photosynthesis at the leaves of *Citrullus lanatus* - Rica F1.

Figura 6. Dinamica diurnă a fotosintezei la frunzele de *C. lanatus* - Rica F1.

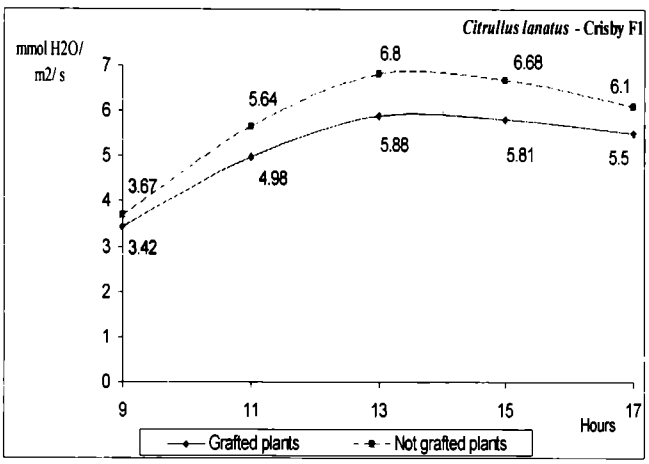


Figure 7. The diurnal dynamics of transpiration at the leaves of *Citrullus lanatus* - Crisby F1.

Figura 7. Dinamica diurnă a transpiraţiei la frunzele de *C. lanatus* - Crisby F1.

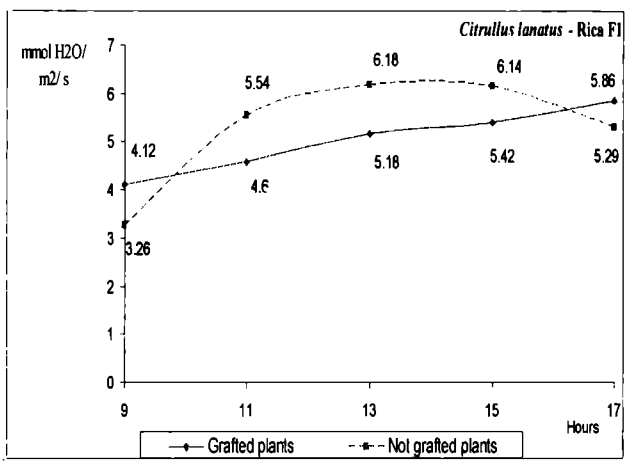


Figure 8. The diurnal dynamics of transpiration at the leaves of *Citrullus lanatus* - Rica F1.

Figura 8. Dinamica diurnă a transpiraţiei la frunzele de *C. lanatus* - Rica F1.

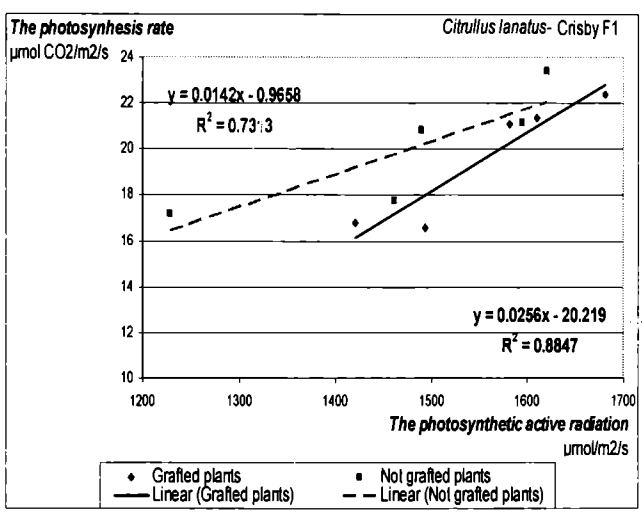


Figure 9. The correlation between the photosynthesis rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Crisby F1.

Figura 9. Corelaţii între rata fotosintezei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Crisby F1.

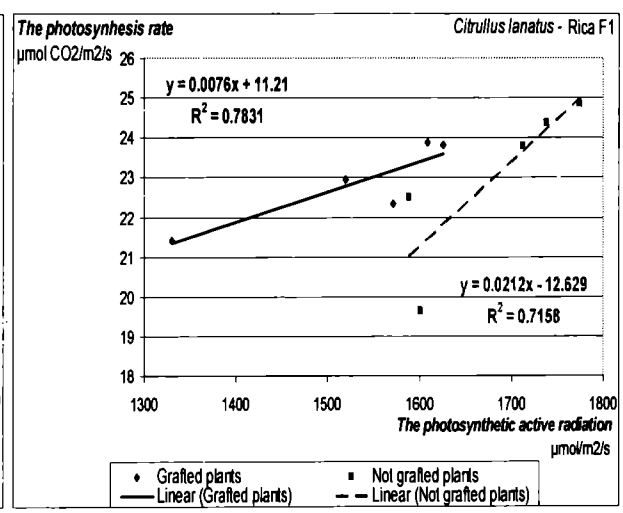


Figure 10. The correlation between the photosynthesis rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Rica F1.

Figura 10. Corelaţii între rata fotosintezei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Rica F1.

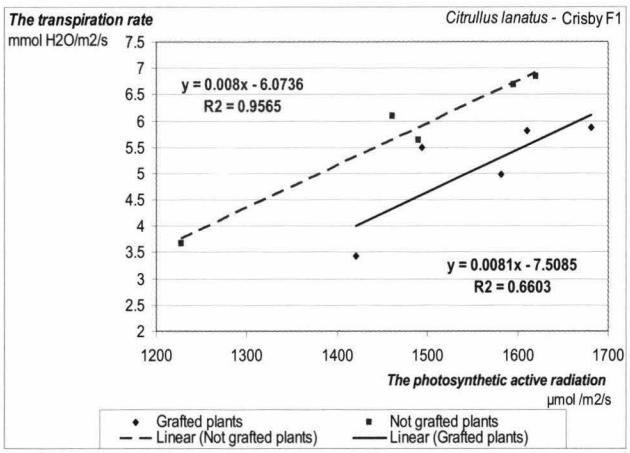


Figure 11. The correlation between the transpiration rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Crisby F1.

Figura 11. Corelaţii între rata transpiraţiei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Crisby F1.

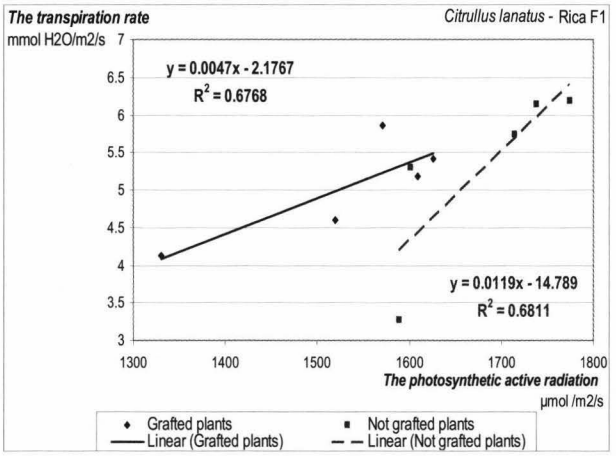


Figure 12. The correlation between the transpiration rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Rica F1.

Figura 12. Corelaţii între rata transpiraţiei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Rica F1.

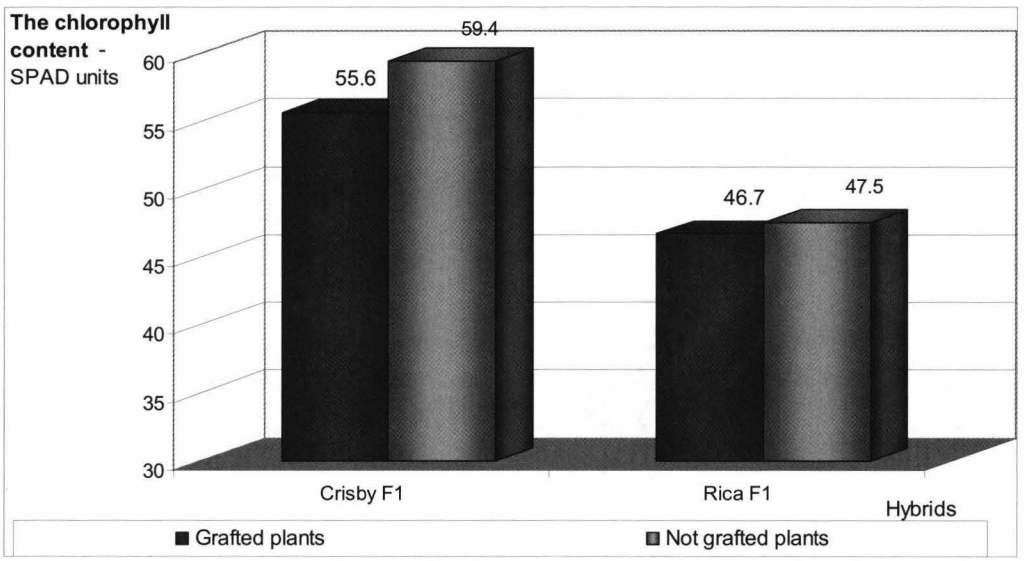


Figure 13. The chlorophyll content at the leaves of *Citrullus lanatus.*

Figura 13. Conţinutul de clorofilă la frunzele de *C. lanatus.*

CONCLUSIONS

The research carried out on grafted watermelon plants revealed the diurnal dynamics of the physiological processes, and allowed to establish a correlation between these processes and the photosynthetic active radiation intensity, and also evidenced the chlorophyll pigment content in grafted plants compared with not grafted plants.

The diurnal dynamics of photosynthesis in watermelon plants shows minimum values in the morning, maximum values at noon and minimum values towards the evening, but the values recorded in grafted plants are smaller compared with not grafted plants. At the Crisby F1 watermelon plants the linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation, show a positive correlation, the coefficient of determination (R^2) being of 0.88 for grafted plants and of 0.73 for not grafted plants, while for the Rica F1 plants the linear regressions performed also show a positive correlation, the coefficient of determination (R^2) being of 0.78 for grafted plants and of 0.71 for not grafted plants.

The diurnal dynamics of the transpiration shows minimum values in the morning, maximum values at noon and minimum values in the evening, but the values recorded in grafted plants are smaller compared with not grafted plants. At Crisby F1 watermelon plants the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation, the coefficient of determination (R^2) being of 0.66 for grafted plants and of 0.95 for not grafted plants, while for the Rica F1 plants the linear regressions performed also positive correlation, the coefficient of determination (R^2) being of 0.67 for grafted plants and of 0.68 for not grafted plants.

The chlorophyll content in the mature leaves of grafted plants is lower, in comparison with the chlorophyll content of not grafted plants, as between the content of chlorophyll pigments and photosynthesis intensity is a positive correlation.

REFERENCES

BIGNAMI C. & NATALI S. 1992. *Relazioni idriche e fotosintesi di alcune specie da frutto*. Giornate Scientifiche SOI / Societa Orticola Italiana. Ravello: 174-175.

LAKSO A. N. 1985. *The effects of water stress potential on physiological processes in fruit crops*. Acta Horticulturae (ISHS). **171**: 275-290.

ROMERO L., BELAKBI. A., RAGALA L., RUIZ J. M. 1997. *Response of plant yield and leaf pigments to saline conditions: effectiveness of different rootstocks in melon plants (Cucumis melo* L.*)*. Soil Science, Plant Nutrition. **43**: 855-862.

RUIZ J. M., BELAKBIR A., LOPEY-CANTARERO I., ROMERO I. 1997. *Leaf - macronutrient content and yield in grafted melon plants. A model to evaluate the influence of rootstock genotype*. Scientia Horticulturae. **71**: 227-234.

YETISIR H., SARI N., YUCEL S. 2003. *Rootstock rezistence to Fusarium wilt and effect on watermelon fruit yield and quality*. Phytoparasitica. **31**: 163-169.

Nicolae Ion, Lascu Nicolae
Department of Biology, Faculty of Horticulture,
University of Craiova, A. I. Cuza Street, No.13,
200585, Craiova, Romania
E-mail: ionnicolaebio@yahoo.com
E-mail: lascu_nicolae@yahoo.com

Toma Vasile
CCDCPN Dăbuleni,
Dolj, Romania
E-mail: vtoma@yahoo.com

Received: March 30, 2011
Accepted: August 2, 2011

SPECIES WITH POTENTIAL FOR ANTHOCYANINS EXTRACTION IN ARGEŞ COUNTY FLORA

SOARE Liliana Cristina, FERDEŞ Mariana, DOBRESCU Codruţa-Mihaela

Abstract. The anthocyanins constitute a major flavonoid group, which is responsible for colours ranging from salmon-pink to red and violet to dark blue in plant tissues. Anthocyanin biosynthesis in plants is generally upregulated in response to one or more environmental stressors: strong light, UV-B radiation, temperature extremes, drought, ozone, nitrogen and phosphorus deficiencies, bacterial and fungal infections, wounding, herbivory, herbicides, and various pollutants. Anthocyanins are of interest for two reasons: they can be used in the technological field as natural colorants and have important implications in the field of human health. Numerous studies indicate the potential effect that this family of flavonoids may have in reducing the incidence of cardiovascular diseases, cancer, hyperlipidaemias and other chronic diseases through the intake of anthocyanin-rich foods. The anthocyanin distribution in plants is also important in chemotaxonomy. In the flora of Argeş county, there have been identified 242 species with potential for anthocyanins extraction. These species belong to 43 families; the greatest number of species characterizes the families: Asteraceae: 27, Lamiaceae: 26, Rosaceae: 21, Fabaceae: 17, Scrophulariaceae: 15, Campanulaceae: 12 and Violaceae: 10. 79.34% of the identified species can be used for the extraction of anthocyanins from flowers, 16.94 % from fruits, 2.90% from flowers and fruit, 0.82 % from leaves and bracts.

Keywords: anthocyanins, Argeş flora, flowers, fruits, leaves, bracts.

Rezumat. Specii cu potenţial pentru extracţia antocianilor din flora judeţului Argeş. Antocianii constituie un grup major de flavonoide responsabil pentru culorile ce variază de la roz-somon la roşu, violet până la albastru închis în ţesuturile plantelor. În plante, biosinteza antocianilor este, în general, stimulată ca răspuns la unul sau mai mulţi factori de stres din mediu: lumină puternică, radiaţii UV-B, temperaturi extreme, uscăciune, ozon, deficit de azot şi fosfor, infecţii bacteriene şi fungice, răniri, specii ierbivore, ierbicide şi diferiţi poluanţi. Antocianii prezintă interes din două motive: ei pot fi utilizaţi în tehnologie, drept coloranţi alimentari, dar şi în domeniul sănătăţii umane. Numeroase studii indică efectul potenţial pe care această familie de flavonoide o poate avea în reducerea incidenţei bolilor cardiovasculare, cancer, hiperlipidemie şi alte boli cronice prin aportul de alimente bogate în antociani. În flora judeţului Argeş au fost identificate 242 de specii cu potenţial pentru extracţia antocianilor. Acestea aparţin la 43 de familii, cel mai mare număr de specii aparţinând familiilor: Asteraceae: 27, Lamiaceae: 26, Rosaceae: 21, Fabaceae: 17, Scrophulariaceae: 15, Campanulaceae: 12 şi Violaceae: 10. 79,34% dintre speciile identificate pot fi utilizate pentru extracţia antocianilor din flori, 16,94 % din fructe, 2,90% din flori şi fructe, 0,82 % din frunze şi bractee.

Cuvinte cheie: antociani, flora judeţului Argeş, flori, fructe, frunze, bractee.

INTRODUCTION

The anthocyanins constitute a major flavonoid group, which is responsible for colours ranging from salmon-pink to red and violet to dark blue in plant tissues (ANDERSEN, 2008). Anthocyanins are present in vegetative and reproductive plant organs. More than 500 different anthocyanins have been identified. The most common anthocyanins in higher plants are: delphinidin, cyanidin, petunidin, pelargonidin, peonidin and malvidin. The glycosides of the three non-metylated anthocyanins (delphinidin, cyanidin and pelargonidin) are the most abundant in nature, representing 80% of leaf pigments, 69% in fruits and 50% in flowers. Anthocyanin biosynthesis in plants is generally upregulated in response to one or more environmental stressors (HATIER & GOULD, 2009). These include: strong light, UV-B radiation, temperature extremes, drought, ozone, nitrogen and phosphorus deficiencies, bacterial and fungal infections, wounding, herbivory, herbicides, and various pollutants (MCCLURE, 1975; CHALKER-SCOTT, 1999). Anthocyanins are interesting natural compounds that can be used as food colorants as they may display a wide range of attractive colours, they are water-soluble and have health-promoting effects. According to the numbering system used by the **Codex Alimentarius Commission,** anthocyanins (any anthocyanin-derived colorant) are listed as a natural colorant by the European Union (EU) legislation as product E163 (MATEUS & DE FREITAS, 2008). Anthocyanins have important implications in the field of human health. Numerous studies indicate the potential effect that this family of flavonoids may have in reducing the incidence of cardiovascular disease, cancer, hyperlipidemias and other chronic diseases through the intake of anthocyanin-rich foods. The anthocyanin distribution in plants is also important in chemotaxonomy. The aim of this study was to identify the species of plant from the spontaneous flora of Argeş county that can be used to extract anthocyanins.

MATERIAL AND METHODS

The list of species with potential for anthocyanins extraction was prepared on the basis of authors' own observations and data from literature (DRĂGHICI, 1968; DRĂGHICI & SOARE, 2002; NEBLEA, 2007; STANCU, 2005; ALEXIU, 2008). For each species was mentioned the organ (organs) that has potential for the extraction of anthocyanin pigments. Plants included in the list were selected based on specific color of anthocyanins. There were taken into account the frequent species (CIOCÂRLAN, 2009) and those that do not have very small flowers. Database made will serve to the further study of anthocyanin pigments contained in the organs of various species.

RESULTS AND DISCUSSIONS

There have been identified 242 species with potential for anthocyanins extraction in the flora of Argeş county. This species belong to 43 families. The families with the greatest number of species are: Asteraceae – 27, Lamiaceae – 26, Rosaceae – 21, Fabaceae – 17, Scrophulariaceae – 15, Campanulaceae – 12 and Violaceae – 10.

79.34% of the identified species can be used for the extraction of anthocyanins from flowers (fl.), 16.94 % from fruits (fr.), 2.90% from flowers and fruits, 0.82 % from leaves (lv.) and bracts (br.) (Fig. 1).

The list of species includes: **Aristolochiaceae:** 1. *Asarum europaeum* L. (fl.); **Ranunculaceae:** 2. *Aconitum moldavicum* HACQ. (fl.), 3. *A. tauricum* WULF. subsp. *tauricum* (fl.), 4. *Adonis aestivalis* L. (fl.), 5. *Consolida regalis* (DC.) S.F. GRAY subsp. *regalis* (fl.), 6. *Heleborus purpurascens* WALDST. et KIT. (fl.), 7. *Nigella arvensis* L. (fl.), 8. *Thalictrum aquilegiifolium* L. (fl.); **Papaveraceae:** 9. *Corydalis cava* SCHWEIGG. et KÖRTE (fl.), 10. *C. solida* (L.) CLAIRV. (fl.), 11. *Papaver rhoeas* L. (fl.); **Caryophyllaceae:** 12. *Dianthus carthusianorum* L. (fl.), 13. *Kohlrauschia prolifera* (L.) KUNTH (fl.), 14. *Lychnis flos-cuculi* L. (fl.), 15. *Silene acaulis* (L.) JACQ. subsp. *acaulis* (fl.); **Polygonaceae:** 16. *Polygonum bistorta* L. (fl.), 17. *P. hydropiper* L. (fl.), 18. *P. minus* HUDSON (fl.), 19. *P. mite* SCHRANK (fl.), 20. *P. persicaria* L. (fl.), 21. *P. viviparum* L. (fl.), 22. *Rumex alpinus* L. (fr.), 23. *R. obtusifolius* L. subsp. *obtusifolius* (fr.); **Plumbaginaceae:** 24. *Limonium gmelinii* (WILLD.) O. KUNTZE (fl.); **Grossulariaceae:** 25. *Ribes alpinum* L. (fr.), 26. *R. petraeum* WULFEN in JACQ. (fr.); **Saxifragaceae:** 27. *Saxifraga oppositifolia* L. subsp. *oppositifolia* (fl.); **Rosaceae:** 28. *Crataegus monogyna* JACQ subsp. *monogyna* (fr.), 29. *Fragaria vesca* L. (fr.), 30. *F. viridis* WESTON subsp. *viridis* (fr.), 31. *Geum rivale* L. (fl.), 32. *Cerasus avium* (L) MOENCH (fr.), 33. *Prunus spinosa* L. subsp. *spinosa* (fr.), 34. *Rosa canina* L. (fl., fr.), 35. *R. corymbifera* BORKH. (fl., fr.), 36. *R. gallica* L. (fl., fr.), 37. *R. pendulina* L. (fl., fr.), 38. *R. tomentosa* SM. (fl., fr.), 39. *Rubus caesius* L. (fr.), 40. *R. canescens* DC. (fr.), 41. *R. hirtus* W. et K. (fr.), 42. *R. idaeus* L. (fr.), 43. *R. montanus* LIB. ex LEJ. (fr.), 44. *R. praecox* BERTOL. (fr.), 45. *R. radula* WEIHE ex BOENN. (fr.), 46. *R. sulcatus* VEST ex TRATT. (fr.), 47. *Sanguisorba minor* SCOP. subsp. *minor* (fl.), 48. *S. officinalis* L. (fl.); **Fabaceae:** 49. *Coronilla varia* L. (fl.), 50. *Galega officinalis* L. (fl.), 51. *Lathyrus hirsutus* L. (fl.), 52. *L. niger* (L.) BERNH. (fl.), 53. *L. nissolia* L. (fl.), 54. *L. sylvestris* L. (fl.), 55. *L. tuberosus* L. (fl.), 56. *L. vernus* (L.) BERNH. (fl.), 57. *Ononis arvensis* L. (fl.), 58. *Trifolium alpestre* L. (fl.), 59. *T. medium* L. (fl.), 60. *T. pratense* L. (fl.), 61. *Vicia cracca* L. (fl.), 62. *V. dumetorum* L. (fl.), 63. *V. sepium* L. (fl.), 64. *V. tenuifolia* ROTH (fl.), 65. *V. villosa* ROTH (fl.); **Lythraceae:** 66. *Lythrum salicaria* L. (fl.); **Onagraceae:** 67. *Chamerion angustifolium* L. (fl.), 68. *Ch. dodonaei* VILL. (fl.), 69. *Epilobium collinum* C.C. GMELIN (fl.); **Thymelaeacea:** 70. *Daphne mezereum* L. (fl., fr.); **Cornaceae:** 71. *Cornus mas* L. (fr.), 72. *C. sanguinea* L. (fr.); **Celastraceae:** 73. *Euonymus europaeus* L. (fr.), 74. *E. verrucosus* SCOP. (fr.); **Rhamnaceae:** 75. *Frangula alnus* MILLER (fr., med., tinct.), 76. *Rhamnus cathartica* L. (fr.); **Geraniaceae:** 77. *Geranium palustre* L. (fl.), 78. *G. phaeum* L. (fl.), 79. *G. pratense* L. (fl.), 80. *G. robertianum* L. (fl.), 81. *G. sylvaticum* L. (fl.); **Linaceae:** 82. *Linum austriacum* L. (fl.), 83. *L. perenne* L. (fl.); **Polygalaceae:** 84. *Polygala amara* L. (fl., med.), 85. *P. major* JACQ. subp. *major* (fl.), 86. *P. vulgaris* L. subsp. *vulgaris* L. (fl., med.); **Apiaceae:** 87. *Ligusticum mutellina* (L.) CRANTZ (fl.); **Malvaceae:** 88. *Lavatera thuringiaca* L. (fl.), 89. *Malva sylvestris* L. (fl.); **Violaceae:** 90. *Viola ambigua* WALDDST. et KIT. (fl.), 91. *V. canina* L. (fl.), 92. *V. collina* Besser (fl.), 93. *V. dacica* BORBÁS (fl.), 94. *V. declinata* W. et K. (fl.), 95. *V. hirta* L. (fl.), 96. *V. mirabilis* L. (fl.), 97. *V. odorata* L. (fl.), 98. *V. reichenbachiana* JORDAN ex BOREAU (fl.), 99. *V. riviniana* REICHENB. (fl.); **Brassicaceae:** 100. *Dentaria bulbifera* (L.) CRANTZ (fl.); **Ericaceae:** 101. *Brukenthalia spiculifolia* (SALISB.) REICHENB. (fl.), 102. *Rhododendron myrtifolium* SCHOTT et KOTSCHY (fl.), 103. *Vaccinium myrtillus* L. (fr.), 104. *V. vitis-idaea* L. (fr.); **Primulaceae:** 105. *Anagallis arvensis* L. (fl.), 106. *Cortusa matthioli* L. (fl.), 107. *Primula minima* L. (fl.), 108. *Soldanella major* (NEILR.) VIERH. (fl.), 109. *S. pusilla* BAUMG. (fl.); **Gentianaceae:** 110. *Centaurium erythraea* RAF. subsp. *erythraea* (fl.), 111. *Gentiana acaulis* L. (fl.), 112. *G. asclepiadea* L. (fl.), 113. *G. nivalis* L. (fl.), 114. G. *verna* L. (fl.), 115. *Gentianella amarella* (L.) BÖRNER (fl.), 116. *G. austriaca* (A. et J. KERN.) HOLUB (fl.); **Apocynaceae:** 117. *Vinca herbacea* WALDST. et KIT. (fl.); **Oleaceae:** 118. *Ligustrum vulgare* L. (fr.); **Boraginaceae:** 119. *Anchusa officinalis* L. (fl.), 120. *Cynoglossum officinale* L. (fl.), 121. *Echium vulgare* L. (fl.), 122. *Lythospermum purpurocaeruleum* L. (fl.), 123. *Myosotis alpestris* F.W. SCHMIDT (fl.), 124. *Pulmonaria mollis* WULFEN ex HORNEM. (fl.), 125. *P. rubra* SCHOTT (fl.), 126. *Symphytum officinale* L. subsp. *officinale* (fl.); **Lamiaceae:** 127. *Acinos alpinus* (L.) MOENCH subsp. *alpinus* (fl.), 128. *A. arvensis* (LAM.) DANDY (fl.), 129. *Ajuga genevensis* L. (fl.), 130. *A. reptans* L. (fl.), 131. *Clinopodium vulgare* L. (fl.), 132. *Galeopsis ladanum* L. (fl.), 133. *G. tetrahit* L. (fl.), 134. *Glechoma hederacea* L. (fl.), 135. *G. hirsuta* WALDST. et KIT. (fl.), 136. *Lamium amplexicaule* L. (fl.), 137. *L. maculatum* L. subsp. *maculatum* (fl.), 138. *L. purpureum* L. (fl.), 139. *Origanum vulgare* L. (fl.), 140. *Prunella grandiflora* (L.) SCHOLLER (fl.), 141. *P. vulgaris* L. (fl.), 142. *Salvia nemorosa* L. (fl.), 143. *S. pratensis* L. subsp. *pratensis* (fl.), 144. *S. verticilata* L. (fl.), 145. *Scutellaria altissima* L. (fl.), 146. *S. galericulata* L. (fl.), 147. *S. hastifolia* L. (fl.), 148. *Stachys germanica* L. (fl.), 149. *S. officinalis* (L.) TREV. (fl.), 150. *S. palustris* L. (fl.), 151. *S. sylvatica* L. (fl.), 152. *Teucrium chamaedrys* L. (fl.); **Scrophulariaceae:** 153. *Bartsia alpina* L. (fl.), 154. *Melampyrum bihariense* A. KERN. (br.), 155. *Pedicularis verticillata* L. (fl.), 156. *Verbascum phoeniceum* L. (fl.), 157. *Veronica austriaca* L. (fl.), 158. *V. teucrium* L. (fl.), 159. *V. chamaedrys* L. subsp. *chamaedrys* (fl.), 160. *V. hederifolia* L. subsp. *hederifolia* (fl.), 161. *V. officinalis* L. (fl.), 162. *V. opaca* FR. (fl.), 163. *V. persica* POIR. (fl.), 164. *V. polita* FR. (fl.), 165. *V. spicata* L. subsp. *spicata* (fl.), 166. *V. orchidea* CRANTZ (fl.), 167. *V. urticifolia* L. (fl.); **Solanaceae:** 168. *Atropa belladonna* L. (fr.), 169. *Solanum dulcamara* L. (fl.), 170. *S. nigrum* L. (fr.); **Lentibulariaceae:** 171. *Pinguicula vulgaris* L. (fl.); **Campanulaceae:** 172. *Campanula alpina* JACQ. (fl.), 173. *C. bononiensis* L. (fl.), 174. *C. cervicaria* L. (fl.), 175. *C. cochleariifolia* LAM. (fl.), 176. *C. glomerata* L. subsp. *glomerata* (fl.), 177. *C. patula* L. (fl.),

178. *C. persicifolia* L. (fl.), 179. *C. rapunculoides* L. (fl.), 180. *C. rapunculus* L. (fl.), 181. *C. sibirica* L. (fl.), 182. *C. trachelium* L. (fl.), 183. *Phyteuma orbiculare* L. (fl.); **Caprifoliaceae:** 184. *Lonicera xylosteum* L (fr.), 185. *Sambucus ebulus* L. (fr.), 186. *S. nigra* L. (fr.), 187. *S. racemosa* (fr.), 188. *Viburnum opulus* L. (fr.), 189. *V. lantana* L. (fr.); **Dipsacaceae:** 190. *Knautia arvensis* (L.) J.M.COULT. subsp. *arvensis* (fl.), 191. *Knautia arvensis* (L.) J. M. COULT. subsp. *rosea* (BAUMG.) SOÓ (fl.), 192. *K. dipsacifolia* KREUTZER subsp. *lancifolia* (HEUFF.) EHREND. (fl.); **Asteraceae:** 193. *Arctium lappa* L. (fl.), 194. *A. minus* BERNH. (fl.), 195. *A. tomentosum* MILL. (fl.), 196. *Aster alpinus* L. (fl.), 197. *A. amellus* L. (fl.), 198. *Carduus acanthoides* L. (fl.), 199. *C. crispus* L. subsp. *crispus* (fl.), 200. *C. personata* (L.) JACQ. subsp. *personata* (fl.), 201. *Centaurea apiculata* LEDEB. subsp. *spinulosa* (ROCHEL) DOSTÁL (fl.), 202. *C. micranthos* S.G. GMEL. ex HAYEK (fl.), 203. *C. cyanus* L. (fl.), 204. *C. phrygia* L. (fl.), 205. *C. scabiosa* L. (fl.), 206. C. *stenolepis* A. KERN. subsp. *stenolepis* (fl.), 207. *Cicerbita alpina* (L.) WALLR. (fl.), 208. *Cichorium inthybus* L. subsp. *inthybus* (fl.), 209. *Cirsium arvense* (L.) SCOP. (fl.), 210. *C. canum* (L.) ALL. (fl.), 211. *C. palustre* (L.) SCOP. (fl.), 212. *C. rivulare* (JACQ.) ALL. (fl.), 213. *C. vulgare* (SAVI.) TEN. (fl.), 214. *C. waldsteinii* ROUY (fl.), 215. *Eupatorium cannabinum* L. (fl.), 216. *Onopordon acanthium* L. (fl.), 217. *Prenanthes purpurea* L. (fl.), 218. *Serratula tinctoria* L. (fl.), 219. *Xeranthemum annuum* L. (fl.); **Trilliaceae:** 220. *Paris quadrifolia* L. (fr.); **Liliaceae:** 221. *Colchicum autumnale* L. (fl.), 222. *Convallaria majalis* L (fr.), 223. *Erythronium dens-canis* L. subsp. *dens-canis* (lv.), 224. *Lilium martagon* L. (fl.), 225. *Muscari comosum* (L.) MILL. (fl.), 226. *Scilla bifolia* L. subsp. *bifolia* (fl.), 227. *Majanthemum bifolium* (L.) F. W. SCHMIDT (fr.), 228. *Polygonatum latifolium* (JACQ.) DESF. (fr.), 229. *P. odoratum* (MILL.) DRUCE (fr.), 230. *P. verticilatum* (L.) ALL. (fr.); **Alliaceae:** 231. *Allium scorodoprasum* L. (fl.), 232. *A. lusitanicum* LAM. (fl.); **Iridaceae:** 233. *Crocus vernus* (L.) HILL. (fl.), 234. *Gladiolus imbricatus* L. (fl.), 235. *Iris graminea* L. (fl.), 236. *I. ruthenica* KER-GAW. (fl.), 237. *I. sibirica* L. (fl.); **Orchidaceae:** 238. *Dactylorhiza cordigera* (FR.) SOÓ subsp. *cordigera* (fl.), 239. *Dactylorhiza maculata* (L.) SOÓ subsp. *maculata* (fl.), 240. *Gymnadenia conopsea* (L.) R. BR. (fl.), 241. *Orchis coriophora* L. subsp. *coriophora* (fl.); **Araceae:** 242. *Arum maculatum* L. (fr.).

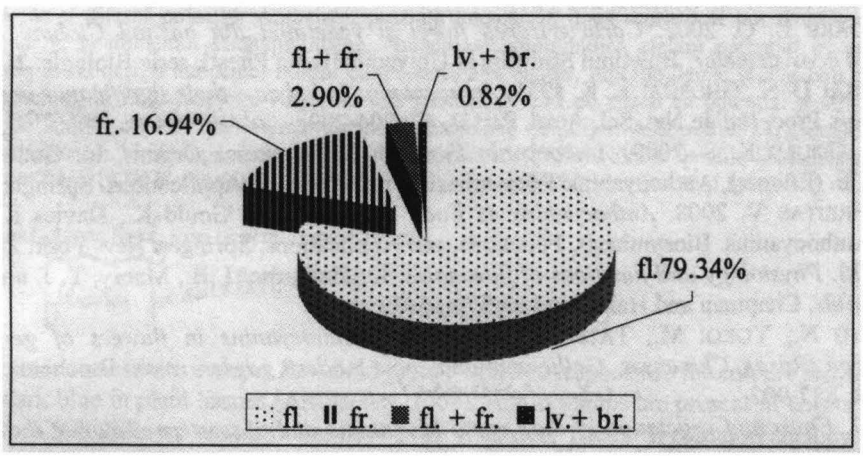


Figure 1. Distribution of anthocyanins in the organs of the identified species (br.-bracts, fl.-flowers, fr.-fruits, lv.-leaves).
Figura 1. Distribuţia antocianilor în organele speciilor identificate (br.-bractee, fl.-flori, fr.-fructe, lv.-frunze).

The anthocyanin distribution in plants is also important in chemotaxonomy. Thus, during a wide survey of flower flavonoids in a variety of sections in the genus *Rosa*, altogether 11 anthocyanins were identified. According to the anthocyanin distribution patterns in the genus, eight groups were identified (MIKANAGI et al., 2000). In the *Brassicaceae* around 45 different anthocyanins have been reported to occur in various species. All anthocyanins are either based on cyanidin or pelargonidin (ANDERSEN & JORDHEIM, 2006). Studies on the distribution pattern of anthocyanins in species of *Salvia* and other *Lamiaceae* have shown that the red, scarlet and pink-colored flower varieties contained pelargonidin, the blue ones delphinidines, and the amethyst- and grape-violet-colored ones were based on cyanidines derivatives (HAQUE et al, 1981). The 3-rhamnoside-5-glucosides of petunidin (71%), delphinidin (12%) and malvidin (9%) have been isolated from the purple-blue flowers of *Vicia villosa* (CATALANO et al., 1998). In orchids, cyanidin 3-oxalylglycosides have previously been reckoned to be remarkable taxonomic markers of certain European genera (*Dactylorhiza*, *Nigritella*, *Orchis* and *Ophrys*) (STRACK et al., 1989).

CONCLUSIONS

In the flora of Argeş county, there have been identified 242 species that can be used to extract anthocyanins. The families with the greatest number of species are: Asteraceae – 27, Lamiaceae – 26, Rosaceae – 21, Fabaceae – 17, Scrophulariaceae – 15, Campanulaceae – 12 and Violaceae – 10. 79.34% of the identified species can be used for the extraction of anthocyanins from flowers (fl.), 16.94 % from fruit (fr.), 2.90% from flowers and fruit, 0.82 % from leaves (lv.) and bracts (br.). Database made will serve to the further study of anthocyanin pigments contained in the organs of various species.

ACKNOWLEDGEMENTS

"This work has benefited from financial support through the 2010 POSDRU/89/1.5/S/52432 project, ORGANIZING THE NATIONAL INTEREST POSTDOCTORAL SCHOOL OF "APPLIED BIOTECHNOLOGIES" WITH IMPACT ON ROMANIAN BIOECONOMY", project co-financed by the European Social Fund through the Sectoral Operational Programme Human Resources Development 2007-2013.

REFERENCES

ALEXIU V. 2008. *Cormoflora judeţului Argeş*. Edit. Ceres. Bucureşti: 70-263.

ANDERSEN ØM. 2008. *Recent Advances in the Field of Anthocyanins – Main Focus on Structures*. In: Daayf Fouad & Lattanzio Vincenzo (Eds.) Recent Advances in Polyphenol Research. Edit. Wiley-Blackwell. United Kingdom: 167-201.

ANDERSEN ØM. & JORDHEIM M. 2006. *The Anthocyanins*. In Andersen ØM. & Markham K. R. Flavonoids. Chemistry, Biochemistry and Applications. Taylor & Francis Group. New York: 471-552.

CATALANO G., FOSSEN T., ANDERSEN ØM. 1998. *Petunidin 3-O-alpha-rhamnopyranoside-5-O-beta-glucopyranoside and other anthocyanins from flowers of Vicia villosa*. Journal Agricultural Chemical. **46**: 4568-4570.

CIOCÂRLAN V. 2009. *Flora Ilustrată a României, Pteridophyta et Spermatophyta*. Edit. Ceres. Bucureşti: 121-1076.

CHALKER-SCOTT L. 1999. *Environmental significance of anthocyanins in plant stress responses*. Photochemistry and Photobiology: **70**: 1-9.

DRĂGHICI B. 1968. *Flora and vegetation of Dâmbovicioara Valley and of Piatra Craiului eastern slope*. Ph.D. Thesis. University of Bucharest. Romania. 285 pp.

DRĂGHICI B. & SOARE L. C. 2002. *Caracterizarea florei şi vegetaţiei din bazinul Ciobani cu aspecte privind deteriorarea ecosistemelor*. Buletinul Ştiinţific al Universităţii din Piteşti, seria Biologie. **2**: 9-11.

HAQUE M. S., GHOSHAL D. N., GHOSHAL K. K. 1981. *Anthocyanins in Salvia – their significance in species relationship and evolution*. Proc. Indian Nat. Sci. Acad. Part B. **47**: 204-209.

HATIER J. H. B. & GOULD K. S. 2009. *Anthocyanin Function in Vegetative Organs*. In: Gould K., Davies K. & Winefield Ch. (Editors), Anthocyanins. Biosynthesis, Functions, and Applications. Springer, New York: 1-20.

MATEUS N. & DE FREITAS V. 2008. *Anthocyanins as Food Colorants*. In: Gould K., Davies K. & Winefield Ch. (Editors), Anthocyanins. Biosynthesis, Functions, and Applications. Springer. New York: 283-304.

MCCLURE J. W. 1975. *Physiology and functions of flavonoids*. In: Harborne, J. B., Mabry, T. J. and Mabry H. (Eds.), *The Flavonoids*. Chapman and Hall, London: 970-1055.

MIKANAGI Y., SAITO N., YOKOI M., TATSUZAWA F. 2000. *Anthocyanins in flowers of genus Rosa, sections Cinnamomeae (Rosa), Chinenses, Gallicanae and some modern garden roses*. Biochemical Systematics and Ecology. **28**: 887-902.

NEBLEA M. A. 2007. *Flora and vegetation of the Leoata Mountains and of western sector of the Bucegi Mountains*. Ph.D. Thesis, University of Bucharest Romania. 402 pp.

STANCU I. D. 2005. *Flora şi vegetaţia munţilor Râiosu şi Buda, Masivul Făgăraş*. Edit. Universităţii din Piteşti: 1-266.

STRACK D., BUSCH E., KLEIN E. 1998. *Anthocyanin patterns in European orchids and their taxonomic and phylogenetic relevance*. Phytochemistry. **28**: 2127-2139.

Soare Liliana Cristina
University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca,
Mănăştur Street, No. 3, Cluj-Napoca, Romania
University Politechnica of Bucharest, Romania
Splaiul Independenţei Street, No. 313, Bucharest, Romania
E-mail: soleil_cri@yahoo.com,

Ferdeş Mariana
University Politechnica of Bucharest, Romania
Splaiul Independentei Street, No. 313, Bucharest, Romania
E-mail: marianaferdes@yahoo.com,

Dobrescu Codruţa-Mihaela
University of Piteşti, Faculty of Sciences
Târgul din Vale Street, No. 1, Piteşti, Romania
E-mail: codrutza_dobrescu@yahoo.com

Received: March 31, 2011
Accepted: August 31, 2011

COMPARATIVE RESEARCH REGARDING THE CHEMICAL COMPOSITION OF VOLATILE OILS FROM *Mentha longifolia* (L.) HUDS.

ANDRO Anca Raluca, BOZ Irina, ZAMFIRACHE Maria-Magdalena, BURZO Ioan

Abstract. The analysis of the chemical composition of volatile oils obtained from medicinal plants is a concern for many researchers. In this study, we analysed the chemical constituents of four essential oils extracted from aerial organs of the species *Mentha longifolia* (L.) HUDS. The main chemical compounds identified in the volatile oil from the whole plant are: linalool (64.881%), carvone (15.478%), limonene (9.048%) and myrcene (3.586%).

Keywords: volatile oil, *Mentha longifolia* (L.) HUDS., medicinal plant, aerial organs, chemical constituents.

Rezumat. Cercetări comparative privind analiza chimică a uleiurilor volatile de *Mentha longifolia* (L.) HUDS. Analiza compoziţiei chimice a uleiurilor volatile obţinute din plante medicinale, reprezintă o preocupare pentru mulţi cercetători. În prezentul studiu am analizat compuşii chimici din patru uleiuri volatile extrase din organele aeriene ale speciei *Mentha longifolia* (L.) HUDS. Principalii compuşi chimici identificaţi în uleiul volatil al întregii plante sunt: linalool (64,881 %), carvonă (15,478 %), limonen (9,048 %) şi mircen (3,586 %).

Cuvinte cheie: ulei volatil, *Mentha longifolia* (L.) HUDS., plantă medicinală, organe aeriene, compuşi chimici.

INTRODUCTION

One of the most representative genera of the Lamiaceae family is *Mentha*. The *Mentha* genus has a complex taxonomy, which makes species identification difficult because of phenotypic plasticity, genetic variability and due to the fact that most species are able to produce hybrids by crossing (HARLEY, 1972).

Of the genus *Mentha* species, *M. longifolia* (L.) HUDS. has the highest prevalence in Romania, as it can be seen from plains to mountains, on wet and marshy places on waterfronts, along roads, in meadows and water meadows (GUŞULEAC, 1961).

On the surface of air organs it has secretory hairs that produce volatile oils, fact which gives the plant aromatic properties.

The analysis of the chemical composition of volatile oils obtained from medicinal plants is a concern for many researchers. In this study we aimed at analysing the chemical composition of the volatile oils of *M. longifolia*, during flowering phenophase and to correlate these data with those already present in literature.

Recent research on the chemical composition of volatile oil from the species *M. longifolia* were conducted by MKADDEM et al. (2009). They identified in the analysed oil pulegone (54.41%), isomenthone (12.02%), 1,8-cineole (7.41%) and borneol (6.85%) as main compounds. Also, DŽAMIĆ et al. (2010) have analysed the volatile oil extracted from *M. longifolia* identifying as main compounds: trans-and cis-dihydrocarvone (23.64% and 15.68%), piperitone (17.33%), 1,8 - cineole (8.18%) and neoisodihydrocarveol (7.87%).

MATERIAL AND METHODS

The aerial organs of the species *M. longifolia* were collected in July 2010 when the plant was in the flowering phenophase. The plant was taken from the banks of the Bârlad River at Negreşti in Vaslui County. The species was determined by Nicolae Ştefan, taxonomist within the Faculty of Biology, "Al. I. Cuza" University in Iaşi.

The volatile oils were extracted with the Clevenger device, in accordance with the European Pharmacopoeia standards the Laboratory of Plant Physiology, Faculty of Biology, "Al. I. Cuza" University of Iaşi. The plant material was crushed, placed in the apparatus ball and distilled for 3 hours.

There were obtained four essential oils: from the aerial parts of the plant, the plant stems, leaves and one from the flowers.

To separate and identify the chemical compounds of the essential oils we used GC_MS (Gas Chromatography coupled with Mass Spectrometry) at the Research Centre for Agri-food products, the Faculty of Horticulture of the University of Agricultural Sciences and Veterinary Medicine of Bucharest.

RESULTS AND DISCUSSIONS

As a result of our investigations on the four essential oils from *M. longifolia* species, it was identified the presence of 34 chemical compounds. Only 10 chemical compounds were present in all four samples, thus giving the aromatic character of these oils. It has also been reported that some compounds are found in one, two or three samples.

The main compounds identified in the four oil samples are: linalool (64.881% -71.902%), carvone (4.016% - 15.478%), limonene (3.259% - 9.048%), β - caryophyllene (1.054% - 4.518%) and germacrene D (1.601% - 4.984%).

Menthol, characteristic to the genus *Mentha* (GALEOTTI et al., 2001), was found in very small quantities and only in the oil obtained from the leaves (0.089%) and whole plant (0.111%).

For oils that were derived from whole plant and plant stems were identified 19 compounds and in oils obtained from plant leaves and flowers were identified 23 compounds. The main chemical compounds identified in the whole plant volatile oil are: linalool (64.881%), carvone (15.478%), limonene (9.048%) and myrcene (3.586%). Linalool is the predominant compound in all the four oil samples that we analysed. The greatest amount of linalool was recorded in the sample containing volatile oil from the plant stems (71.902%), while the smallest amount was reported in the volatile oil from the flowers of the plant (68.829%). Another volatile chemical compound reported in the four samples of essential oil is carvone. The maximum amount of this compound was recorded in the volatile oil sample from the whole plant (15.478%) and minimum quantity of oil was reported in the sample obtained from the stems of the plant (4.016%). Regarding the content of limonene, a compound present in the four different biological samples, it was also found in large quantities. Its evolution is similar to that of linalool, the difference being the reduced quantity of limonene. Thus, the oil extracted from the whole plant has a limonene content of 9.048%, while the oil obtained from the stems of the plant contains only 3.259%. There had been recorded significant amounts of β-caryophyllene (4.518%) and germacrene D (4.984%) in the oil extracted from the leaves of *M. longifolia* species, in the other samples being present in smaller quantities, as shown in Table 1. Also, there can be observed the presence of significant amounts of myrcene in the oil extracted from the whole plant (3.586%) and leaves (2.035%) and the presence of β-myrcene in the oil obtained from the stems (3.001%) and plant flowers (2.398%).

Research studies concerning the chemical composition of *M. longifolia* essential oil were also conducted by MKADDEM et al. (2009). They analysed volatile oils from *M. longifolia* and *M. longifolia* collected in the region of Gabes, Tunisia. The compounds reported in significant amounts in the oil of *M. longifolia* were: pulegone (54.41%), isomenthone (12.02%), 1,8-cineole (7.41%), borneol (6.85%), and piperitenone oxide (3.19%).

Linalool is a monoterpene often found in the volatile oil from medicinal plants and is used for its anti-inflammatory properties (PEANA et al., 2002). Limonene, also a monoterpene, is known for its sedative and expectorant action (WAGNER, 1995) (cf. BOZ IRINA et al., 2010). Germacrene D is a hydrocarbon in sesquiterpenes class, which is often used as a pesticide (http:sun.ars-grin.gov), while carvone has antifungal properties (HARTMANS, 1995).

Table 1. Chemical composition of the volatile oils from *M. longifolia* species.
Tabel 1. Compoziția chimică a uleiurilor volatile provenite de la specia *M. longifolia*.

No.	Compounds	Whole plant (%)	Stems (%)	Leaves (%)	Flower (%)
1	α – Thujen	-	-	0.255	-
2	α – Pinene	0.334	0.220	0.490	0.284
3	Sabinene	0.462	0.354	-	0.325
4	β – Pinene	0.743	0.649	-	0.507
5	Myrcene	3.586	-	2.035	-
6	β – Myrcene	-	3.001	-	2.398
7	3 – Octanol	-	0.519	0.348	0.513
8	Limonene	9.048	3.259	5.148	7.165
9	Eucalyptol	-	1.256	-	-
10	Trans – β – Ocimene	0.912	0.971	0.110	0.086
11	Cis – β – Ocimene	-	-	1.129	0.697
12	Linaool	64.881	71.902	70.719	68.829
13	Menthone	0.089	-	0.111	-
14	α – Terpineol	0.304	-	0.195	0.189
15	Terpinolen	-	-	-	0.068
16	Dihydrocarvone	0.482	-	-	0.163
17	Dihydrocarveol	-	-	0.236	-
18	Carvone	15.478	4.016	6.690	13.737
19	Cis – hexenil-isovalerate	0.201	0.377	0.270	-
20	Hexenil valerate	-	0.207	-	-
21	Hexenil isovalerate	-	-	-	0.178
22	Dihydroedulan	0.110	-	0.250	-
23	Dihydrocarvil acetate	0.146	-	0.347	-
24	β – Burbonen	0.119	0.391	0.156	0.137
25	β – Elemene	-	-	-	0.055
26	Cis – jasmone	-	-	0.118	0.068
27	β – Caryophyllene	1.054	3.106	4.518	1.522
28	α – Caryophyllene	-	0.174	0.167	0.102
29	Epi-biciclosesquifelandren	-	0.265	-	0.036
30	Germacrene D	1.178	2.980	4.984	1.601
31	Germacrene D – 4 – ol	-	-	0.310	-
32	Elixene	0.162	0.481	0.780	0.231
33	α – Farnesene	-	-	0.093	-
34	Δ – Cadinene	0.071	0.226	-	0.062

CONCLUSIONS

Knowledge of the chemical compounds in essential oils obtained from *M. longifolia* is very important. The high content of linalool and limonene (in the whole plants and/or in analysed organs) from this volatile oil can gives anti-inflammatory, sedative and expectorant properties. Due to their properties the plant can be used in obtaining pharmaceutical products.

ACKNOWLEDGEMENTS

This work was supported by the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/88/1.5/S/47646] and by program "Developing the innovation capacity and improving the impact of research through post-doctoral programmes" POSDRU/89/1.5/S/49944.

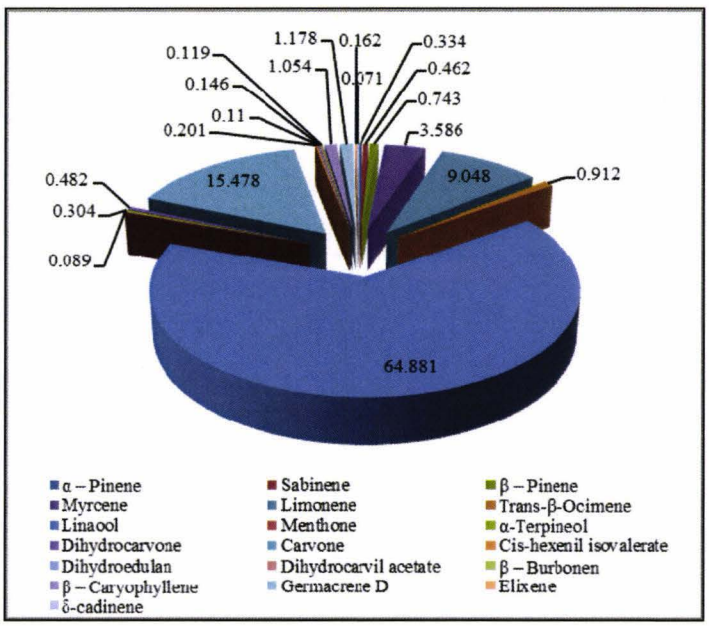


Figure 1. The chemical composition of essential oil of *M. longifolia* (whole plant).
Figura 1. Compoziţia chimică a uleiului volatil de *M. longifolia* (planta întreagă).

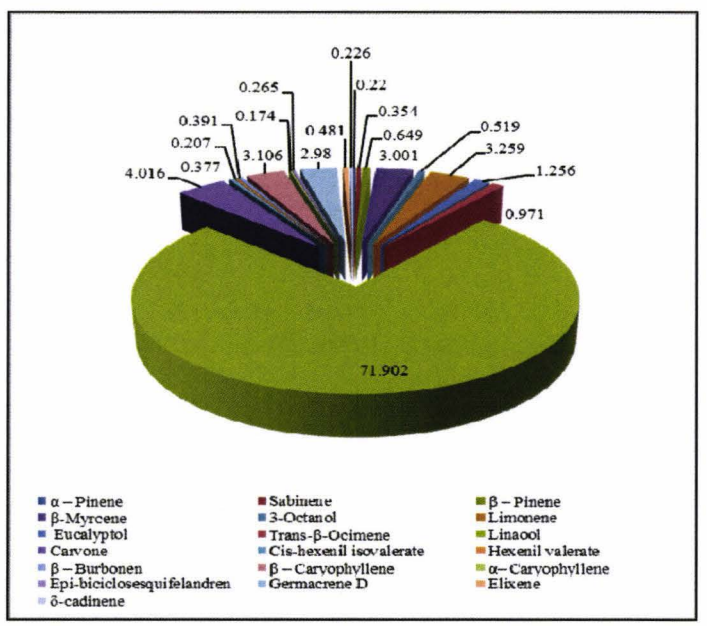


Figure 2. The chemical composition of essential oil of *M. longifolia* (stems).
Figura 2. Compoziţia chimică a uleiului volatil de *M. longifolia* (tulpini).

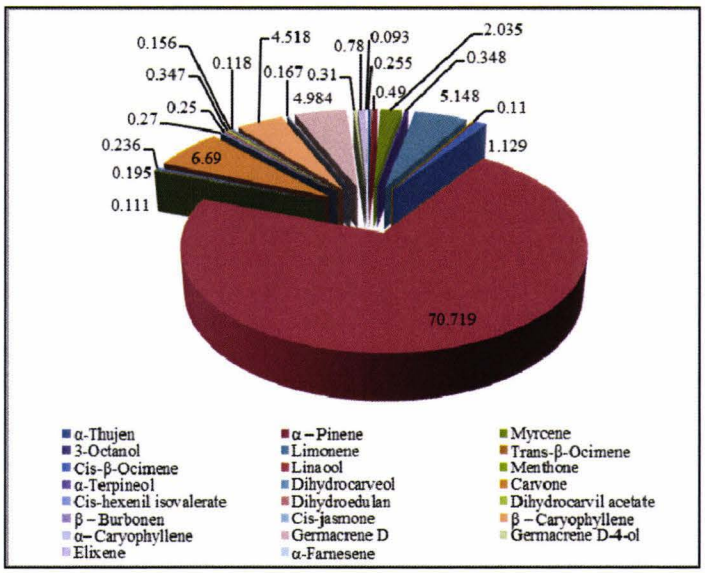


Figure 3. The chemical composition of essential oil of *M. longifolia* (leaves).
Figura 3. Compoziţia chimică a uleiului volatil de *M. longifolia* (frunze).

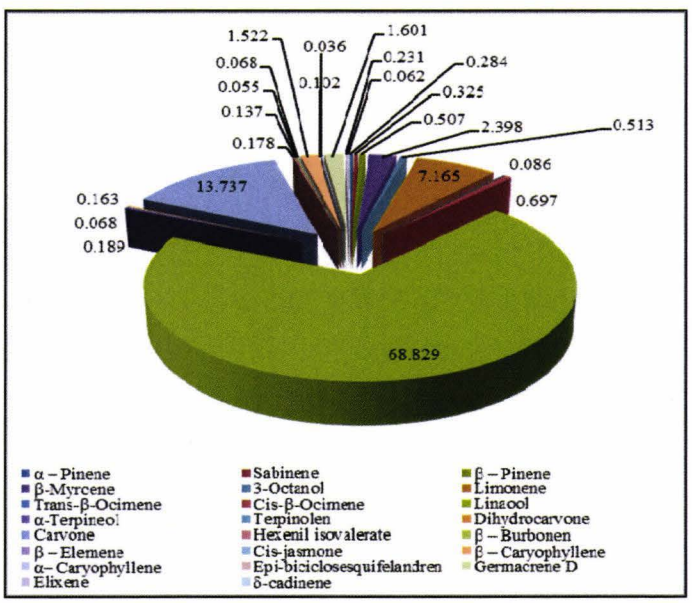


Figure 4. The chemical composition of essential oil of *M. longifolia* (flowers).
Figura 4. Compoziţia chimică a uleiului volatil de *M. longifolia* (flori).

REFERENCES

BOZ IRINA, PĂDURARIU CLAUDIA, ZAMFIRACHE MARIA-MAGDALENA, BURZO I., DUNCA SIMONA, ŞTEFAN M., IVĂNESCU LĂCRĂMIOARA, OLTEANU ZENOVIA, BADEA MONICA LUMINIŢA, GOSTIN IRINA, ANDRO ANCA-RALUCA. 2010. *Chemical composition and antimicrobial activities of volatile oil in some Lamiaceae species.* Journal of Biodiversity and Ecological Sciences. Edit. Iau (Tonekabon Branch), Tonekabon. **1**(1): 21-27.

DŽAMIĆ ANA M., SOKOVIĆ MARINA D., RISTIĆ M., NOVAKOVIĆ M., SLAVICA GRUJIĆ-JOVANOVIĆ, TEŠEVIĆ V., MARIN P. 2010. *Antifungal and antioxidant activity of Mentha longifolia (L.) Hudson (Lamiaceae) essential oil*, Botanica Serbica.. Edit. University of Belgrade, Belgrad. **34**(1): 57-61.

GALEOTTI NICOLETTA, MANNELLI L., MAZZANTI GABRIELA, BARTOLINI A., GHELARDINI CARLA. 2001. *Menthol: a natural analgesic compound.* Neuroscience Letters. Edit. Elsevier, East Park. **322**: 145-148.

GUŞULEAC M. 1961. *Labiate.* In: Flora Republicii Populare Române. Edit. Academiei R.P.R., Bucureşti. **8**: 82-394.

HARLEY R. M. 1972. *Mentha.* In: Flora Europaea. Edit. Cambridge University Press, Cambridge. **3**: 183-186.

HARTMANS K., DIEPENHORST P., BAKKER W., GORRIS L. 1995. *The use of carvone in agriculture: sprout suppression of potatoes and antifungal activity against potato tuber and other plant disease.* Industrial Crops and Products. Edit. Elsevier, Oxford. **4**(1): 3-13.

PEANA A. T., D'AQUILA P. S., PANIN F., SERRA G., PIPIA P., MORETTI M. D. L. 2002. *Anti-inflammatory activity of linalool and linalyl acetate constituents of essential oils*. Phytomedicine. Edit. Urban & Fischer Verlag, Munchen. **9**(8): 721-726.

MKADDEM M., BOUAJILA J., ENNAJAR M., LEBRIHI A., MATHIEU F., ROMDHANE M. 2009. *Chemical Composition and Antimicrobial and Antioxidant Activities of Mentha (longifolia L. and viridis) Essential Oils*. Journal of food science. Edit. Institute of Foods Technologists, United States. **74**(7): 358-363.

***. http:sun.ars-grin.gov – Germacrene D (accesed: November 15, 2009).

Andro Anca Raluca, Boz Irina, Zamfirache Maria-Magdalena
Department of Plant Biology, Faculty of Biology, "Al. I. Cuza" University of Iaşi,
20 A "Carol I" Boulevard, Iaşi, Romania
E-mail: anca_andro@yahoo.com
E-mail: irina_berciu@yahoo.com
E-mail: magda@uaic.ro

Burzo Ioan
Faculty of Horticulture, USAMV Bucharest,
Boulevard Mărăşeşti, No. 59, Bucharest, Romania
E-mail: post@info.usamv.ro.

Received: March 23, 2011
Accepted: August 4, 2011

SELF-THINNING FOR HUNGARIAN AND TURKEY OAK WILDLINGS

BERCEA Iulian

Abstract. Some conclusions arise from the research: The Hungarian oak has the capacity to grow under the crown, given certain light intensity restrictions, powerfully correlated with the crown loosening; Within forest areas where light intensity is lower than 5% of that in open field, crown loosening is needed during seed year or during first year of vegetation in order to insure the regeneration; In brushes under 0.8 consistency, the crown loosening can be done up until the third year of vegetation at the latest; The powerful self-thinning during the first year took place within small seedling felling (0.5 H), while under the dense stand the powerful self-thinning took place where the crown density of the stand was higher; Climatic changes, manifested through very dry years, with high temperatures for a long time and very large amplitudes in a short period of time, have resulted in changing the intensity of natural self-thinning for the Hungarian and Turkey oak, for the brush overall, but also within the areas where exploitation-regeneration works were carried out through progressive cuttings, which determines differentiated carrying out of the cuttings for rejuvenation and approaching a new strategy to maintain an d perpetuate Hungarian oak on its territories.

Keywords: *Quercus frainetto* TEN., *Quercus cerris* L., climatic changes, self-thinning.

Rezumat. Eliminarea naturală în semințișurile de gârniță și cer. Scopul cercetărilor s-a concentrat pe stabilirea intensității de eliminare naturală în semințișurile naturale de gârniță și cer în condițiile schimbărilor climatice actuale. Din cercetări efectuate, am constatat următoarele: gârnița are capacitatea de a se instala sub masiv în anumite limite ale intensității luminii aflată în corelație directă cu deschiderea arboretului; în porțiunile de pădure în care intensitatea luminii este sub 5% din cea în terenul descoperit este necesară deschiderea masivului în anul de sămânță sau în primul an de vegetație pentru asigurarea regenerării; în arboretele cu consistența sub 0,8 deschiderea masivului se poate face până cel mai târziu în anul al treilea de vegetație; eliminarea mai puternică în primul an, s-a produs în ochiurile cu dimensiuni mici (0,5 H), iar sub masiv eliminarea mai puternică s-a produs acolo unde consistența arboretului este mai mare. Schimbările climatice care se manifestă prin anii foarte secetoși, cu temperaturi ridicate o perioadă îndelungată de timp și amplitudini foarte mari în intervale scurte de timp au condus la modificarea ritmului eliminării naturale în semințișurile de gârniță și cer, atât pe ansamblul arboretelor cât și în suprafețele parcurse cu lucrări de exploatare-regenerare prin tratamentul tăierilor progresive, fapt ce determină aplicarea diferențiată a tratamentelor cu tăieri de regenerare și abordarea unei noi strategii pentru menținerea și perpetuarea gârniței în teritoriile ocupate.

Cuvinte cheie: *Quercus frainetto* TEN., *Quercus cerris* L., schimbări climatice, eliminare naturală.

INTRODUCTION

The Hungarian oak (*Quercus frainetto* TEN.) and Turkey oak (*Quercus cerris* L.) ecosystem formed stable structures along the time, but they were seriously affected by the long drought followed by a mass drying between 1989 and 1994.

The intensity of the drying phenomenon manifested differently for the two species being more intense for Hungarian oak in stands with diverse ages (BADEA & TĂNASE, 2002).

The shown decline for Hungarian oak and Turkey oak determined to start research activities which had an extensive evolution character of stands condition and affectation degree of the trees. The drying phenomenon affected the exploitable stands in different stages of regeneration works application, and through the extraction of the dried trees from the stands, it was produced a disordered state of the works and of course of the regenerations (BERCEA, 2005; BERCEA & SĂRARU, 2008). The behaviour of the two species was different especially during the process of fructification, the Hungarian oak did not fructify but the Turkey oak continued to fructify in a normal way. From the exploitable stands where there were made regeneration cuttings, there were not extracted trees in order for the works to be continued normally, because the annual possibility is harvested from the accidental products appeared because of the drying phenomenon. The drought affected the installed seedlings as well and the Hungarian oak stands regeneration had a hard period.

The very large areas occupied by Hungarian oak and Turkey oak within the studied territory and especially in the south part of it, do not allow to recover the forests through plantations and the substitution of these species is impossible. Because of the climate and physical-geographical conditions of this territory, the Hungarian oak and the Turkey oak are the single species which can form forests and valorize in a superior way the existent resorts.

This way, it appeared the necesity to adapt the known solutions for the regeneration of Hungarian oak and Turkey oak stands to the new conditions and to find the optimal solutions in order to straighten out the regeneration process of the two species.

The researches about the natural selection in Hungarian oak and Turkey oak seedlings in different real conditions will lead to scientifical solutions about the possibilities of Hungarian oak and turkey oak regeneration which can be appliable in production.

The researches were performed between 2000 and 2006. During the researches, we had difficulties because of the lack of the necesarry apparatus and skilled personnel to perform the simultaneous determinations of the temperature

and brightness in all experimental blocks, as well as the appeared difficulties caused by the lack of Hungarian oak fructification, in the first years since the researches start.

For our researches, it is very important the way of natural selection of the seedlings under the mountain, at certain lighting intensities, within the different dimensions eyes, at the edge of the mountains or eyes, as well as in the conditions appeared because of uncontrolled opening of the stands as a result of Hungarian oak and Turkey oak stands drying phenomena.

MATERIAL AND METHODS

In order to reach the objective, there were placed 40 permanent trial areas in which there were performed evaluations in the autumn of every year, being determined the number of the seedlings on species.

The study of the natural selection in Turkey oak seedlings was performed within the trial areas placed in u.a. 46B in U.P. II Bucovăț, 124A in U.P. Seaca de Pădure in Craiova Forest District, u.a. 44B in U.P. I Gogoşu, 66C in U.P. III Filiaşi, 80H, 81D, 82M in U.P. II Argetoaia in Filiaşi Forest District, u.a. 117C in U.P. I Războinicu, 47 C in U.P. IV Şuşița in Strehaia Forest District, u.a. 1A in U.P. III Cărbunești. The determinations were performed in 2003, 2004 and 2005 for the planted seedlings from the 2002 fructification.

For the Hungarian oak, the lack of the fructification, before 2003, did not allow to watch the evolution of seedlings number at the end of the vegetation season for a certain age seedlings. These elements could be determined only for different ages seedlings, planted as a result of a low fructification.

The evolution of the seedlings number provided by a very good fructification could be done only after the Hungarian oak fructification in 2003, being performed evaluations in 2004, 2005 and 2006.

The very high intensity of the fructification in 2003 was determined by us in July 2003 and because of that we started to place trial areas for the Hungarian oak stands in the autumn of 2003 and as a result we could watch the seedling installation and then its selection in its first year, beginning with the spring of 2004, in 52 trail areas placed in U.P. II Argetoaia, u.a. 112B, C; 99F, 88K, Filiaşi Forest District.

The light intensity was determined with a luxmeter. There were performed a lot of observations about the Hungarian oak and Turkey oak natural regenerations in Jiu area in a very long period of time (over 20 years) through the performed production work and acquired results.

RESULTS AND DISSCUTIONS

1. The natural selection of Turkey oak seedlings.

One year after eyes opening, the natural selection in the eyes is between 21% and 59% and under the mountain is between 47% and 72%. The higher selection was produced in the first year, in the eyes of smaller dimensions (0.5H), and under the mountain the higher selection was produced where the stand's consistency is full or almost full. In sufficient humidity years, the light is the main factor in the natural selection of the seedlings, the more light is, and the less eliminated seedlings are.

In the second vegetation year, the Turkey oak natural selection is between 15% and 29% (Table 1), the differences being made by the lighting degree of the seedling, the forest type, the slope exposure, etc.

Table 1. Natural selection of Turkey oak seedlings in the first years of establishment.
Tabel 1. Eliminarea naturală a puieților de cer în primii ani de la instalare.

The researches place	The size of the eyes raported to the hight of the trees	The analyzed period from the autumn of till the autumn of	The eliminated seedlings from the fructification of 2002 (%)		
			In vegetation year	In the eye	Under the mountain
1	2	3	4	5	6
u.a. 46 B, 124 A	Eyes of 0.5 to 1.5H opened in the autumn of 2002. In the situations "in the eye" and "under mountain" the consistency 0.6 to 1.0.	2002 - 2003	I	59	72
		2003 – 2004	II	29	33
		2004 – 2005	III	12	36
44 B, 1 A	Eyes of 0.5 to 2.0H opened in the autumn of 2002. In the situations "in the eye" and "under mountain" the consistency 0.6 to 1.0.	2003 – 2004	II	22	34
		2004 - 2005	III	12	36
66 C, 80 H, 82 M	Eyes of 0.5 to 1.5H. In the situations "in the eye" and "under mountain" the consistency 0.5 to 0.8.	2003 - 2004	II	19	28
		2004 – 2005	III	11	27
81 D, 117 C, 47 C, 55 C	Eyes of 1.0H. In the situations "in the eye" and "under mountain" the consistency 0.5 to 0.8.	2002 - 2003	I	21	47
		2003 – 2004	II	15	33
		2004 - 2005	III	10	29

Legend: u.a. = working unit; U.P. = working section; H = mean height/of the tree.
Legendă: u.a. = unitate amenajistică; U.P. = Unitate de Producție; H = înălțimea copacilor.

In the third vegetation year, the natural selection is still high under the mountain (between 29% and 36%) being permanently higher than that from the eyes (between 10% and 12%). The seedlings can still be observed within the mountain, in the areas where the light intensity overtakes 15% from the light intensity in the open field and at the edge of the eyes where they use the lateral light.

2. Natural selection of Hungarian oak seedlings.

Hungarian oak stands which reached the exploitation age and being caught in a full process of regeneration by the intense drying between 1990 and 2001, the natural selection of the seedling can be watched in the open eyes for a long time. In these eyes, on some central parts, the stage of massif is closed and it began the phenomena of natural selection because of the intraspecific and interspecific competition. Our objective was to establish the determinant factors of the natural selection within the individual development period of the seedlings with effects on the natural regeneration establishment.

In the trail areas in which it was determined the proportion of the natural selection of the seedlings in the first year, it resulted different percentages between 20% and 70%, being differentiated through: the number of plantlets which appear in a certain area, the evolution of the climate factors during the vegetation season, the conditions of seedlings development (under the mountain laterally protected by the parental mountain, open ground), the size of the acorn from which it appears, the genetic information received from the parental trees, the adaptation to the environment conditions of the area etc.

The plantlets density on area unit, can become from the first year a restrictive factor, through the big number of plantlets on a square meter (over 160).

The natural selection of the seedlings is produced through the competition of the roots for water and, later, on a smaller scale, together with the trunk development and leaves growing, through the competition of the underground part. The selection proportion in the first year is the same, both for the seedlings under the mountain and for those in the other areas of the eye, in the stands placed on the plane fields. For the stands placed on the southern slopes, the natural selection is higher under the mountain by 34%.

In the period August - September, after the appearance of the humidity deficit in the soil together with the daily medium temperature raising and insolation, the seedlings dry in a percentage of 40% - 60%. From the performed researches resulted that to the end of September, the leaves dry, making the impression of entering earlier in the vegetative rest (checking the leaves colour) but, analyzing the situation of the trunk and root, it is observed that the seedlings dried.

In the second year of vegetation the natural selection for the Hungarian oak is between 18% and 36% (Table 2), the differences being made by the lighting degree of the seedling, the forest type, the slope exposure, etc.

In the third year of vegetation, the natural selection is still high under the mountain being permanently higher than that one in the eyes. The seedlings within the mountain, in the areas in which the light intensity exceeds 15% from the light intensity in open ground and at the edge of the eyes where the seedlings can use the lateral light.

The natural selection of the sapling is produced under the strong influence of the ecological external factors. The establishment of Hungarian oak saplings in a year with a very good fructification, its density on a square meter, growth strength and its resistance to the action of the preservative ecological factors are the result of the ecological factors which are favourable to the species.

The study of the establishment of Hungarian oak sapling in a year with a very good fructification creates the possibility of watching the result of the ecological factors which are favourable to this process. The observation of their manifestation during a vegetation season shows us the limits in which Hungarian oak seedlings can establish and develop normally, helping us to determine the level from which they become limitative, as well as the proportion of these factors which can be compensated in a way in which the result of their action to be favourable to the establishment and keeping the Hungarian oak sapling.

One year after the eyes opening, the natural selection in the eyes is between 20% and 63% and under the mountain round the eyes is between 54% and 70%. The stronger selection in the first year produced in small dimensions eyes (0.5H), and under the mountain the stronger selection produced in the place where the stand's consistency is full or almost full. It must be said that 2004 was reach in precipitations uniformly distributed during the vegetation season except August when it was very hot. We can draw a conclusion that in years with sufficient humidity, the light is the main factor in the seedlings natural selection, the more light is, the less eliminated seedlings are. Within the studied territory, there is enough heat in order to establish the Hungarian oak seedlings; it becomes limitative only during the drought periods, as it happened in August 2004 when it could be observed the drying of the seedlings in the areas with a high exposure to the sun.

The natural selection of the Hungarian oak and Turkey oak seedling is a complex process which manifests differently based on the unfavourable result of the determinant ecological factors like light, soil humidity and heat, which are specific to both species. To these, there are added the seedlings density in the area as well as the genetic adaptation variability of the species which appears especially at the extreme amplitudes of limitative manifestation of one of the ecological factors. If for the compensation of the humidity lack, the Hungarian oak adapted developing a very strong root, the lack of light cannot be compensated and becomes the limitative factor which mainly determines the natural selection of the seedlings.

Table 2. Natural removal of Hungarian oak seeds in the first years of establishment.
Tabel 2. Eliminarea naturală a semințișului de gârniță în primii ani de la instalare.

The researches place	The diameter of the eyes reported to the height of the trees	The analyzed period from the autumn of till the autumn of	The eliminated seedling from the fructification of 2003 (%)		
			In vegetation year	In the eye	Under the mountain
1	2	3	4	5	6
U.P. II Argetoaia, u.a. 112 C	Eyes of 0.5 to 1.5H opened in the autumn of 2003. In the situations under the mountain with the consistency of 0.6 to 1.0.	2003 - 2004	I	63	70
		2004 – 2005	II	33	35
		2005 – 2006	III	15	40
u.a. 112 B	Eyes of 0.5 to 2.0H opened in the autumn of 2003. In the situations under the mountain with the consistency of 0.6 to 1.0.	2004 – 2005	II	19	36
		2005 - 2006	III	12	38
u.a. 99 F	Eyes of 0.5 to 1.5H. In the situations under the mountain with the consistency of 0.5 to 0.8.	2004 - 2005	II	18	22
		2005 – 2006	III	11	26
u.a. 88 K	Eyes of 1.0H. In the situations under the mountain with the consistency of 0.5 to 0.8.	2003 - 2004	I	20	54
		2004 – 2005	II	14	32
		2005 - 2006	III	12	36

Legend: u.a. = working unit; U.P. = working section; H = mean height/of the tree.
Legendă: u.a. = unitate amenajistică; U.P. = Unitate de Producție; H = înălțimea copacilor.

In the pure stands of Hungarian oak with ages of over 40 years there are saplings with bush aspect of which origin has not been established yet in the scientific works. The researches showed that all patterns came from seeds and present the following features:

- at a depth soil between 5 and 15 cm, the root starts with a strong tap root which enters in depth;
- from the same level of the root, the trunk ramifies in two, three patterns which reach the soil surface, in an inclined position under an angle between 150 and 200^0;
- all patterns which start from the same root have on all aerial part, branches which cover the trunk completely and because of the lateral branches development, the trunk is not evidently differentiated;
- the trunks and the lateral branches develop horizontally and because of that they have a bush aspect and cover the soil on an area between $1m^2$ to $4m^2$;
- the trunks of these patterns have a bush aspect because the repeated self cutting back of the seedlings in a long period of time from 4 to 10 years;
- the level establishment of the pre-existent saplings with bush aspect appears in over 40 years old stands which are capable to fructify, in which because of different reasons the consistency reduced under 0.8;
- the establishment of these types of saplings under the mountain with a high resistance against the shadowing is specific only to the Hungarian oak;
- in the pure stands of Hungarian oak, with a consistency under 0.7, this type of manifestation and establishment of the saplings forms a sublevel with a height of no more than 2.5 meters which cover the soil in a percentage of 30% - 70%;
- the light intensity in areas covered with pre-existent bush aspect patterns is between 15% to 35% from the light intensity in the open ground;
- the growth of the empty space in the superior ceiling of the maternal stands leads to the activation of height growth of the patterns established in the light, favourising the correction of only one trunk but with limited effects for the trunk rectitude and further growths.

The age of the bush aspect patterns is between 3 and 40 years.

CONCLUSIONS

The development way of the Hungarian oak seedlings in their first years of life shows the high degree of species adaptability to develop in extreme conditions of humidity and temperature. Because of the reduced density of the seedlings, they self cut back beginning with the second year and they develop their branches from the base almost parallel with the ground, the growth in height are small and after a sufficient approaching to the nearby seedlings garland and the creation of the forest microclimate, through which it is kept easily the soil humidity, it starts the height vigorous growth.

The Hungarian oak has the capacity to establish under the mountain in certain limits of light intensity which is in direct correlation with stand's opening. At full consistency of the maternal stand, the light intensity is only 4% from that one in the open ground, there were kept 27% from the number of established seedlings. At the light intensity of 5% to 8% from that one in open ground, there were 30% to 32% from the number of established seedlings. At an intensity of 30% to 35% from that one in the open ground, there were kept 64% to 65% from the total number of established seedlings.

In the stands with full o5r almost full consistency, in which the light intensity is 4% to 5% from the light intensity in the open ground, there are kept between 4 and 15 seedlings on a square meter, in the first year of life, enough for regeneration. In the second year of vegetation, the number of seedlings reduces between 1 and 4 seedlings on a square meter, insufficient for regeneration. In those parts of the forest in which the light intensity is under 5% from that one in the open ground, it is necessary to open the massif in the first year of vegetation for regeneration.

In the stands with under 0.8 consistency, the massif opening can be done till the third year of vegetation.

One year after the eyes opening, the natural selection in the eyes between 20% and 63% and under the massif, round the eyes, it is between 54% and 70%. The stronger selection in the first year produced in a smaller dimensions eyes (0.5H) and under the mountain the stronger selection produced where the stand's consistency is higher. In years with sufficient humidity, the light is the main factor in the natural selection of the seedlings. So, the more light is, the less eliminated seedlings are.

The natural selection of Hungarian oak and Turkey oak sapling is a complex process which manifests differently based on the unfavourable result of the determinant ecological factors like light, soil humidity and heat, which are specific to both species to whom it is added the seedlings density in that area as well as the genetic adaptation variability of the species which manifests in the extreme amplitudes parts of limitative manifestation of one of the ecological factors. The main factor which influences the natural selection is light, followed by the soil humidity and extreme, very high temperatures.

In the Hungarian oak stands which began to fructify and have the consistency under 0.8, it is an established seedling with bush aspect making a sublevel which participates to forest microclimate keeping.

REFERENCES

BADEA O. & TĂNASE M. 2002. *Romania's Forests Health Status in 2001.* In: "Forest Magazine". **2**: 6-10.

BERCEA I. 2005. *The Hungarian oak and Turkey oak spreading in Jiu area.* In: The bulletin of the scientific session "The Durable Agriculture, the Future Agriculture", the first Edition, Craiova, the 9th – the 10th of December 2005. University of Craiova. Faculty of Agriculture: 3-4.

BERCEA I. & SĂRARU A. 2008. *Researches about the Growing and Developing the Hungarian oak and Turkey oak Seedlings in the Stands of the Western part of Getic Plateau.* In the bulletin of the scientific session "The Durable Agriculture, the Future Agriculture", the 4th edition, Craiova, the 28th, the 29th of November, 2008. University of Craiova. Faculty of Agriculture. Craiova: 42-55.

Bercea Iulian
University of Craiova, Faculty of Agriculture,
Str. Libertăţii, No. 19, Craiova, Romania
E-mail: berceaiulian@yahoo.com

Received: March 27, 2011
Accepted: August 9, 2011

Poëtum sylvicolae BUIA, PĂUN, SAFTA et POP 1959 FROM SOUTH WESTERN PART OF ROMANIA

RĂDUŢOIU Daniel

Abstract. This paper contains all the data from the literature regarding this association but also personal information gathered in the last 10 years. In the study there was taken into consideration only the South-West of Romania, because in this part, *Poa sylvicola* association is widely spread. Currently the phytocoenoses of this association grow in the floodplains of the major rivers in this part of the country. Together with the phytocoenoses edified by *Festuca pratensis* (HUDS. 1762), they represent the main meadows of the specified area. The early mowing of these grasslands allows to the locals to mow them twice, after which they are used as pasture. This is not recommended because it does not allow the species to mature its fruits and seeds and the number of good fodder species decreases in time.

Keywords: association, *Poa sylvicola, Trifolium pallidum*, Oltenia, Romania.

Rezumat. *Poëtum sylvicolae* BUIA, PĂUN, SAFTA et POP 1959 din sud-vestul României. Lucrarea de faţă cuprinde toate datele din literatură referitoare la această asociaţie precum şi informaţiile personale acumulate pe o perioadă de 10 ani. Menţionăm că în studiu a fost luată doar partea de sud-vest a României, deoarece în această parte asociaţia edificată de *Poa sylvicola* are cel mai mare areal. În prezent fitocenozele acestei asociaţii cunosc o dezvoltare în luncile principalelor râuri din această parte a ţării. Alături de fitocenozele edificate de *Festuca pratensis*, reprezintă principalele fâneţe din zonă. Cositul timpuriu al acestor pajişti permite localnicilor efectuarea a două cosiri, după care sunt folosite ca păşune. Nu este indicat acest lucru deoarece nu permite speciilor să-şi matureze fructe şi seminţele şi scade în timp numărul speciilor bune furajere.

Cuvinte cheie: asociaţie, *Poa sylvicola*, *Trifolium pallidum*, Oltenia, România.

INTRODUCTION

The data regarding the presence of this association in the South-West of Romania are very sporadic. Professor Al. Buia (1959) was the first who noticed the presence of some compact phytocoenoses edified by the *Poa sylvicola* sub-Mediterranean taxa in the wetlands of the Jiu and the Teslui floodplains. Subsequently, data on this association are mentioned by various authors (PĂUN, 1966a, 1967; CÂRŢU, 1971, 1976; ZAHARIA, 1972; PĂUN et al., 1973; PĂUN & POPESCU, 1974; ROMAN, 1974; POPESCU, 1974, 1979; COSTACHE, 2005; RĂDUŢOIU, 2006) in this part of the country.

In Romania, this association has been seen only in Babadag Plateau (DIHORU & DONIŢĂ, 1970), although we believe that it is present also in the grasslands of the rivers floodplains in the south-southeast of Romania. Until now there are no data about the presence of such association in other regions of Romania.

Due to the identification of some parts dominated by *Trifolium dubium* (SIBTHORP, 1794) within these phytocoenoses, some authors (PĂUN, 1966b) considered that these areas can be classified as facies, named by them at that time *Poëtum sylvicolae oltenicum trifoliosum dubii.*

The large presence of different species of clover and the lack of *Zingeria pisidica* (BOISSIER, 1854; TUTIN, 1978) species in the Sub-Carpathian hills and depressions led PĂUN et al. (1972) to describe a new sub-association *Poetum sylvicolae trifolietosum* BUIA, PĂUN, SAFTA et POP, 1959.

MATERIAL AND METHODS

The first step in the study of these phytocoenoses was the bibliographic documentation regarding the locations where these phytocoenoses were mentioned until the study properly began. Subsequently, I went on the field in different points of this part of Romania, where I took notes about the floristic composition of the found phytocoenoses. In the study there were taken into account the most representative phytocoenoses.

The data collected in the field were processed in the laboratory, thus drawing some conclusions that are presented in this paper. In our field trips we have observed as much as possible, the current status of vegetation, the dynamics in time and space, the successive directions of the most important phytocoenoses in some areas where the human influence is stronger.

The surveys have been chosen in the areas characteristic for the association, taking into account the minimum area corresponding to this type of phytocoenosis.

To classify the association, there were used the Romanian vegetation synthesis works, carried out by different authors or collectives of authors from Romania or abroad (SOÓ, 1980; BORHIDI, 1996; SANDA et al., 2001; SANDA, 2002).

RESULTS AND DISCUSSIONS

The association edified by *Poa sylvicola* is placed by the majority of phytosociologists in the following superior cenotaxonomic units:

Cl. Molinio-Arrhenatheretea TX. 1937
Ord. Molinietalia caeruleae W. KOCH 1926
Al. Agrostion stoloniferae (SOÓ 1933) 1971
Poëtum sylvicolae BUIA, PĂUN, SAFTA et POP 1959

P. sylvicolae (Table 1). Currently we may say that this association is quite common in the wetlands from many rivers floodplains (the Olt, the Teslui, the Geamărtălui, the Horezu, the Valley of Brâncoveanca Creek, the Jiu floodplain between Răcari and Lişteava, the Cerna of Olteţ, the Motru, the Amaradia, the Pesceana, the Luncavăţ, the Bistriţa of Olt).

The table below shows the floristic composition of this association resulted from the processing of data collected by us in the 10 years of careful observations of these phytocoenoses.

The phytocoenoses of this association are present on lowlands, with shallow groundwater, on gleyic brown alluvial and semi-gleyic soils.

The floristic composition reflects their meso-meso-hygrophilic character. In addition to the species characteristic to the alliance, order and class, there are also present many mesophilic-mesohygrophilic taxa.

The high coverage (close to 100%) is reflected also in the obvious plants stratification: the first layer is composed of *Poa sylvicola* GUSS., *Festuca pratensis* HUDS., *Crepis setosa* (HALLER 1797), *Cichorium intybus* (LINNAEUS 1753) etc., the middle layer of *Trifolium pratense* (LINNAEUS 1753), *T. pallidum* (WETTSTEIN & KITAIBEL 1802), *Lolium perenne* (LINNAEUS 1753), *Poa pratensis* (LINNAEUS 1753); and the lower layer of *Plantago major* (LINNAEUS 1753), *Trifolium repens* (LINNAEUS 1753) and *Taraxacum officinale* (WEBER in WIGGERS 1780) (Fig. 1).

Figure 1. The physiognomy of the grasslands of *Poa sylvicola* in the studied area.
Figura 1. Fizionomia pajiştilor de *P. sylvicola* din teritoriul studiat (original).

Although in the floristic composition of the phytocoenosis there are many weeds, we cannot speak of a ruderalisation of these meadows.

The presence in the association of many herbs and honey plants raises the economic value of the association. It can also noted the large number of pulses (Fig. 2), which significantly increase the value of forage pastures. They are primarily used as grassland (Fig. 3) and further to fall as pasture.

The characteristics of the phytocoenoses identified by us are slightly similar to those described in the SW of Romania: BUIA et al., 1959; BUIA & PĂUN, 1960; PĂUN, 1966, 1967; CÂRȚU, 1971, 1976; ZAHARIA, 1972; PĂUN et al., 1973; PĂUN & POPESCU, 1974; ROMAN, 1974; POPESCU, 1974, 1979.

Unlike the descriptions made in the south of the studied territory (BUIA et al., 1959; PĂUN, 1967; CÂRȚU, 1971 and personal research), it appears that the plant formations from the sub-Carpathian hills and depressions are characterized by the lack of *Zingeria pisidica* species from the floristic composition, which was also noticed by PĂUN et al., (1973) in the grasslands located between Peşteana and the Jiu.

Table 1. *Poetum sylvicolae* BUIA, PĂUN, SAFTA et POP 1959.

Biof.	Geoel.	Survey number	1	2	3	4	5	6	7	8	9	10	11	12	K
		Altitude (m)	300	300	300	350	320	320	360	360	360	420	420	420	
		Exposure	N	NV	NV	V	E	E	-	-	-	-	-	-	
		Inclination (°)	5	5	5	10	10	10	-	-	-	-	-	-	
		Vegetation covering (%)	95	100	100	100	100	100	100	100	100	100	100	100	
		Survey area (m^2)	40	40	40	40	60	60	80	80	80	80	80	80	
Characteristic species of the association															
H.	Submedit.	*Poa sylvicola*	4	5	4	4	5	5	4	4	5	4	5	4	V
T.-HT.	Medit.	*Trifolium pallidum*	+	+	1	+	+	+	1	1	+	+	+	+	V
Agrostion stoloniferae & Molinietalia caeruleae															
H.	Circ.	*Juncus effusus*	+	+	-	+	-	+	+	+	+	-	+	-	IV
H.	Eur. Centr. and de S	*Ranunculus acris* subsp. *friesianus*	+	-	-	+	-	+	-	+	-	-	+	-	III
H.	Circ.	*Agrostis stolonifera*	-	+	+	-	+	-	+	+	+	-	+	-	III
H.	Euras.	*Cichorium intybus*	+	+	+	-	+	-	+	-	+	-	+	-	III
H.	Circ.	*Gratiola officinalis*	+	+	+	+	+	+	-	-	-	-	-	-	III
H.	Euras.	*Mentha longifolia*	+	+	-	+	+	+	-	+	+	-	-	-	III
H.	Euras.	*Stachys officinalis*	-	+	-	+	+	+	-	-	-	-	-	-	II
H.	Euras.	*Senecio erucifolius*	-	-	-	+	+	+	-	-	-	-	-	-	II
Arrhenatherion & Arrhenatheretalia															
H.	Euras.	*Taraxacum officinale*	-	-	-	+	+	+	-	-	-	+	+	+	III
T.-HT.	Euras. Submedit.	*Bromus commutatus*	+	-	+	-	+	-	+	+	+	-	-	-	III
T.	Pont.-Pan.-Balc.	*Rhinanthus rumelicus*	-	-	-	1	1	1	-	+	-	-	+	-	III
H.	Cosm.	*Lolium perenne*	+	+	+	-	-	-	+	+	+	-	-	-	III
H.	Eur.	*Cynosurus cristatus*	+	-	+	-	+	-	-	+	-	-	+	-	III
H.	Eur. Centr. and SE	*Centaurea stenolepis*	-	-	-	+	+	+	-	-	-	-	-	-	II
Molinio-Arrhenatheretea															
H.	Euras.	*Lathyrus pratensis*	+	+	+	-	+	+	+	-	+	+	+	+	V
H.	Euras.	*Festuca pratensis*	+	+	+	+	+	+	-	+	-	+	-	+	IV
H.	Euras.	*Lotus corniculatus*	+	+	+	-	-	-	+	+	+	+	+	+	IV
H.	Euras.	*Potentilla reptans*	+	-	-	+	-	-	+	+	+	+	+	+	IV
H.	Euras.	*Vicia cracca*	+	-	+	-	+	-	-	-	-	+	+	+	III
Ch.	Euras	*Lysimachia nummularia*	-	+	+	-	+	+	+	+	+	-	-	-	III
H.	Circ.	*Lythrum salicaria*	+	+	+	-	-	-	+	+	+	-	-	-	III
G.	Circ.	*Carex hirta*	-	+	-	-	-	-	+	+	+	+	+	+	III
T.-HT.	Eur. Centr.	*Centaurium erythraea*	+	+	+	-	-	-	-	-	-	+	+	+	III
H.	Pont. Medit.	*Galega officinalis*	+	-	+	-	+	-	+	+	+	-	-	-	III
H.	Euras.	*Achillea millefolium*	+	+	+	-	-	-	+	+	+	-	-	-	III
H.	Euras.	*Ranunculus repens*	-	+	-	+	-	+	+	+	+	-	-	-	III
H.	Euras. Submedit.	*Epilobium tetragonum*	+	-	+	-	+	-	+	-	-	+	-	-	III
H.	Circ.	*Poa pratensis*	+	-	-	-	-	-	+	+	+	+	+	+	III
H.	Cosm.	*Holcus lanatus*	-	-	-	+	-	-	+	+	+	-	-	-	II
H.	Euras.	*Plantago lanceolata*	-	+	-	+	+	+	-	-	-	-	-	-	II
H.	Euras.	*Stellaria graminea*	-	+	-	+	+	+	-	-	-	-	-	-	II
H.	Euras.	*Trifolium pratense*	+	-	-	+	+	+	-	-	-	-	-	-	II
H.	Euras.	*Lysimachia vulgaris*	-	-	-	+	+	+	-	-	+	-	-	-	II
H.	Euras.	*Trifolium repens*	+	-	-	-	-	-	-	-	-	+	+	+	II
Festuco-Brometea															
H.	Euras.	*Galium verum*	+	+	+	+	+	+	-	-	-	-	-	-	III
H.	Submedit.	*Agrimonia eupatoria* subsp. *grandis*	-	-	-	+	+	+	-	-	-	-	-	-	II
H.	Cont. Euras.	*Verónica spicata*	-	-	-	+	+	+	-	-	-	-	-	-	II
Variaesyntaxa															
H.	Euras.	*Plantago major*	+	+	+	+	+	+	+	+	+	+	+	+	V
G.	Cosm.	*Equisetum arvense*	+	+	+	+	+	+	+	+	+	-	-	-	IV
H.	Pont.-Pan.-Balc.	*Oenanthe banatica*	-	+	+	-	+	+	-	+	+	-	+	+	IV
T.	Eur. de S	*Xanthium italicum*	-	-	-	+	+	+	+	+	+	-	-	-	III
T.	Eur. Centr. and S	*Crepis setosa*	+	-	+	-	+	-	-	-	+	-	-	+	III
T.,HT., H.	Adv. (N Am.)	*Erigeron annuus* subsp. *strigosus*	-	-	+	-	-	-	+	+	+	+	+	+	III
G.	Euras.	*Sonchus arvensis*	+	+	-	-	+	-	+	+	+	-	-	-	III
Ch.	Eur. Centr. and SE	*Dorycnium herbaceum*	-	-	-	+	+	+	-	+	-	+	-	-	III
HT.	Submedit.	*Dipsacus fullonum*	-	-	-	-	-	-	+	+	+	+	+	+	III
T.	Euras.	*Vicia tetrasperma*	-	+	+	-	+	+	-	-	-	+	+	+	III
H.	Euras.	*Inula britannica*	+	+	+	-	-	-	-	-	-	-	-	-	II
G.	Circ.	*Equisetum telmateia*	+	-	+	-	-	+	-	+	-	-	-	-	II
H.	Euras.	*Tanacetum vulgare*	-	-	-	-	-	-	+	+	+	-	-	-	II

Species present in one survey: T., Euras. *Bidens tripartita* (5), H., Euras. *Juncus inflexus* (5), T., Cosm. *Polygonum lapathifolium* (5), T., Cosm. *Juncus bufonius* (5), T.-HT. Euras. *Matricaria perforata* (5), H., Euras. *Rumex crispus* (5), G., Euras. *Cirsium arvense* (5), T., Euras. *Pulicaria vulgaris* (5), (G) H., Cosm. *Convolvulus arvensis* (6), H., Euras. *Galium mollugo* (10), H., Circ. *Carex spicata* (6), T., Eur. *Trifolium campestre* (6),

T.-HT. Eur. *T. aureum* (6), T., Eur. *T. dubium* (12), H., Euras. *Cruciata laevipes* (6), G., Circ. *Elymus repens* (9), H., Euras. *Dactylis glomerata* (6), H., Euras. *Lathyrus tuberosus* (11), HT.-H. Centr. And E. Eur. *Tragopogon orientalis* (6), H., Euras. *Rorippa sylvestris* (12).
Place and date of performing the surveys: 1. Măciuca - Vâlcea (June 25, 2005); 2. Frasin – Dolj (July 3, 2008); 3. Sopot – Dolj (July 3, 2008); 4. Pietroaia – Dolj (July 3, 2008); 5. Țiu-Cernăteşti – Dolj (July 3, 2008); 6. Lădeşti – Vâlcea (June 25, 2005); 7. Cueni – Vâlcea (June 26, 2003); 8, 9. Roeşti - Vâlcea (June 25, 2005); 10, 11, 12. Copăceni – Vâlcea (June 25, 2005).

Figure 2. Picture with parts of the phytocoenosis where the AD of Fabaceae is high.
Figura 2. Imagine cu porțiuni din fitocenoze unde AD fabaccelor este ridicată (original).

Figure 3. The use of grasslands with *Poa sylvicola*.
Figura 3. Modul de folosire al pajiştilor de *P. sylvicola* (original).

In the phytocoenosis identified by us (especially those from the sub-Carpathian hills and depressions), there can be observed more xerophilous species, which is reflected in the floristic composition by the lack of certain taxa. At this point, the forefront phytocoenoses of this association are those formed by *Festuca pratensis*, *Poa pratensis* and *Alopecurus pratensis*. The more xerophilous character of the phytocoenoses located at higher altitudes and the more hygrophilous character specific to low altitudes is explained by the slope inclination. Within the plain area, phytocoenosis usually develop on flat areas, while within the sub-Carpathian hills and depressions the surface displays a slight inclination. Moreover, the phytosociological analysis helped us select one species (*Trifolium pallidum*) that presents a certain ecological fidelity with *Poa sylvicola*.

CONCLUSIONS

The paper presents the updated chorology of the phytocoenoses dominated by *Poa sylvicola* in this part of the country, where in fact it is the most widely spread.

In the southern areas of the studied territory, the plant formations resent the species *Zingeria pisidica* compared with those from the sub-Carpathian hills and depressions where this taxon is absent.

The relatively high constancy of the species *Trifolium pallidum* in the achieved surveys illustrates certain fidelity of this species with *Poa sylvicola*.

At higher altitudes of the investigated area, the flora composition is richer than that of the grasslands in the south. These grasslands best use climate and soil conditions and therefore they should be preserved in their present condition through rational exploitation measures.

Taking into account the previous research, as well as our personal research, we can say that the name *Trifolio pallidi - Poetum sylvicolae* best fits these phytocoenosis dominated by *Poa sylvicola*.

REFERENCES

BORHIDI A. 1996. *Critical revision of the Hungarian Plant communities*. Janus Pannonicus University. Pécs. H-7601: 43-129.

BUIA AL. & PĂUN M. 1960. *Materiale pentru flora şi vegetaţia împrejurimilor oraşului Craiova*. Comunicări de Botanică. Societatea de Ştiinte Naturale şi geografie din R.P.R. Bucureşti: 281-295.

BUIA AL., PĂUN M., SAFTA I., POP M. 1959. *Contribuţii geobotanice asupra păşunilor şi fâneţelor din Oltenia*. Lucrări Ştiinţifice. Institutul Agronomic „T. Vladimirescu" Craiova. Edit. Agro-Silvică, Bucureşti: 1-90.

CÎRŢU MARIANA. 1971. *Aspecte privind vegetaţia pajiştilor de luncă din Bazinul Amaradiei*. Studii şi cercetări. C.C.S.E. Craiova. Intreprinderea Poligrafică Oltenia, Craiova: 93-98.

CÎRŢU MARIANA. 1976. *Caracterizarea şi clasificarea vegetaţiei din bazinul Amaradiei*. Analele Universităţii Craiova. **7**(17): 45-49.

COSTACHE I. 2005. *Flora şi vegetaţia bazinului hidrografic inferior al râului Motru*. Teză de doctorat. Universitatea din Bucureşti. 290 pp.

DIHORU G. & DONIŢĂ N. 1970. *Flora şi vegetaţia podişului Babadag*. Edit. Academiei R.S.R., Bucureşti. 438 pp.

PĂUN M. 1966a. *Materiale pentru flora şi vegetaţia Raionului Balş*. Lucrări Ştiinţifice. Institutul Agronomic „T. Vladimirescu" Craiova. Edit. Agro-Silvică, Bucureşti. **6**: 35-67.

PĂUN M. 1966b. *Asociaţii de plante bune furajere din Raionul Balş, Regiunea Oltenia*. Buletin Ştiinţific. Institutul Agronomic „T. Vladimirescu". Craiova. **8**: 15-26.

PĂUN M. 1967. *Vegetaţia Raionului Balş. Regiunea Oltenia*. Comunicări de Botanică. Bucureşti. Societatea de Ştiinţe Naturale şi Geografie din R.P.R. Bucureşti. **6**: 121-127.

PĂUN M., POPESCU G., ZAHARIA I. 1972. *Fâneţele din Lunca Jiului de la Bâlteni-Pesceana, important centru floristic al Gorjului*. Studii şi Cercetări. Gorj. Intreprinderea Poligrafică Oltenia, Craiova: 185-192.

PĂUN M., POPESCU G., ZAHARIA I. 1973. *Vegetaţia*. In: Pajiştile din zona subcarpatică a Olteniei. Edit. Scrisul Românesc. Craiova: 98-172.

PĂUN M. & POPESCU G. 1974. *Vegetaţia luncii Jiului dintre Filiaşi şi Zăval (II)*. Studii şi cercetări. Comitetul de Cultură şi Educaţie Socialistă al judeţului Gorj, Târgu Jiu: 23-37.

POPESCU G. 1974. *Studiul floristic şi geobotanic al Bazinului hidrografic al Bistriţei-Vâlcii*. Teza de doctorat. Universitatea din Bucureşti. 303 pp.

POPESCU G. 1979. *Asociaţii vegetale de pajişti mezofile din Bazinul hidrografic al Bistriţei-Vâlcii*. Analele Universităţii din Craiova. Biologie, Agronomie, Horticultură. Intreprinderea Poligrafică Oltenia, Craiova. **10**(20): 27-32.

RĂDUŢOIU D. 2006. *Flora şi vegetaţia bazinului Cernei de Olteţ*. Teza de doctorat. Bucureşti. 281 pp.

ROMAN N. 1974. *Flora şi vegetaţia din sudul podişului Mehedinţi*. Edit. Academiei Române. Bucureşti. 222 pp.

SANDA V., POPESCU A., STANCU DANIELA ILEANA. 2001. *Structura cenotică şi caracterizarea ecologică a fitocenozelor din România*. Edit. Conphis. Bucureşti. 359 pp.

SANDA V. 2002. *Vademecum cenostructural privind covorul vegetal din România*. Edit. Vergiliu. Bucureşti. 331 pp.

SOÓ R. 1980. *Conspectus Florae Vegetationisque Hungariae*. Edit. Academiai Kiadó. Budapest. 556 pp.

ZAHARIA I. 1972. *Flora şi vegetaţia Bazinului Gilort de la limita superioară a pădurii până la confluenţa cu Jiul.* Rezumatul tezei de doctorat. Bucureşti. 59 pp.

Răduțoiu Daniel
University of Craiova, Faculty of Horticulture
Libertăţii Street, No. 15, Craiova, 200585, Romania
E-mail: radutoiudaniel@yahoo.com

Received: March 30, 2011
Accepted: August 6, 2011

STUDY ON VEGETATION OF GLACIAL CIRQUES IN MOLDOVEANU AND GALBENA MOUNTAINS, FĂGĂRAŞ MASSIF

STANCU Daniela Ileana

Abstract. The paper presents the vegetation of glacial cirques from Moldoveanu and Galbena Mountains, Făgăraş Massif. Some of the plant communities, previously cited in this region, have been confirmed by us. Galbena Mountain is populated by small areas of endemic plant formations because of the major presence of limestone and includes an exceptional glacial cirque – Galbena. In the same time, the water of Moldoveanu Lake, which dominates the upper part of the Valea Rea – forms some of the most spectacular waterfalls within these mountains at Buduri, called Budurile Văii Rele. The Valea Rea gradually changes its orientation to the south-east, forming a basin with low slope, currently occupied by a large peat bog located at 2,000-2,100 m height. The peat bog surface exceeds 1 km^2 and its study will continue in the summer of 2011.

Keywords: glacial cirque, Făgăraş Massif, plant communities, characteristic species, vegetation.

Rezumat. Studiu asupra vegetaţiei căldărilor glaciare din Munţii Moldoveanu şi Galbena, Masivul Făgăraş. Lucrarea prezintă vegetaţia căldărilor glaciare din Munţii Moldoveanu şi Galbena, din Masivul Făgăraş. Unele dintre asociaţiile vegetale, citate în regiunea studiată, au fost confirmate şi de noi. Muntele Galbena, este populat pe arii restrânse de plante endemice datorită prezenţei calcarului şi include un circ glaciar de excepţie – Galbena. În acelaşi timp, apele lacului Moldoveanu care domină partea superioară a Văii Rele, se aruncă la Buduri în cele mai spectaculoase cascade din aceşti munţi, numite Budurile Văii Rele. Valea Rea îşi schimbă orientarea în direcţia sud-est formând un bazin cu pantă lină, ocupat de o mare turbărie situată la 2.000-2.100 m.s.m. Suprafaţa turbăriei este de 1 km^2 şi studiul ei va continua în vara anului 2011.

Cuvinte cheie: căldări glaciare, Masivul Făgăraş, asociaţii vegetale, specii caracteristice, vegetaţie.

INTRODUCTION

The distinctive landscape note of the alpine mountains of Făgăraş is given by the expansion and diversity of glacial modelling. Făgăraş is the mountain that holds the largest area of glaciers carved in the Southern Carpathians. In Pleistocene, the Alpine area was located above the regular and permanent snow limit and received sufficient rainfall to supply ice, placing such a spatio-temporal oscillating hionosphere, typical of this era. As a result of their past, Făgăraş Massif present numerous traces: basins, lakes and also ice tongue (FLOREA, 1998). Northern slopes, with sharp gradients, have limited the growth of glaciers in length, while the slow and broad valleys in the south allowed the formation of glaciers with lengths of over 7 km, winding paths, with branches arising from the tributary suspended valleys.

Glacial circuses, locally known as "buckets", vary in appearance and complexity. Their location at 2,000-2,200 m altitude indicates their formation in a recent glacial phase, corresponding to Wurm.

The total composition of the Făgăraş Mountain in metamorphic rocks, suggests a potential monotony of the landscape, but petrographic and structural differences inmodelling exogenous conditions under glacial periglacial and th en crio-nival, explains the diversity of forms encountered in these mountains. The high-glacial complex Viştea Mare - Moldoveanu is dominated by two peaks formed by the trapezium mountain, which can be drawn north and south, Y-shaped symmetrical peaks, thus delimiting four large glacial cirques. The eastern slope of the mountain Viştea Mare - Moldoveanu dominates the upper valley cirque of Valea Rea, occupied by Lake Moldoveanu, which is the start of this valley. The triangular shape of the lake is the result of silting, made by a pouring of the north, north-west. The lake is situated at an altitude of 2,165 m, covers an area of 0.45 ha and has a depth of 2 m. The water of the lake, forms some of the most spectacular waterfalls in these mountains at Buduri, called Budurile Văii Rele (PIŞOTA, 1971).

The Valea Rea gradually changes its orientation to the south-east, forming a broad basin with low slope, currently occupied by a large peat bog located between 2,000 and 2,100 m height. The peat bog surface exceeds 1 km^2 and is drained by a dense network of streams (it seems that here was one of the largest glacial lakes in these mountains, clogged with materials from the steep slopes and invaded Sphagnum later). Glacial valley ends abruptly with a threshold of about 400 m, along which successive steps form several waterfalls called Budurile Văii Rele.

To the south, Galbena Mountain (toponym derived from the major presence of limestone) is the southeastern extension of Mount Moldoveanu and includes an exceptional glacial cirque – Galbena.

The Galbena Lake is located at 2,200 m height, with 1.2 ha surface and a depth of 9 m. The cirque presents an upland terrain, with many rams glacier, marshy areas and three small glacial lakes.

MATERIAL AND METHOD

The plant nomenclature follow Flora Europaea and CIOCÂRLAN, 2000. The vegetation was studied using the principles of the Central European geobotanical school of surveying the vegetation (BRAUN-BLANQUET, 1964). The phytocenological framing of the vegetation follow various authors (SANDA et al., 1998; COLDEA, 1991; SANDA et al., 2001).

RESULTS

Overall, the associations identified follow the next phytocenological framing:

Cls. Thlaspietea rotundifolii BR.-BL. 1948
Ord. *Thlaspietalia rotundifolii* BR.-BL. in BR.-BL. et JENNY 1926
All. *Papavero-Thymion pulcherrimi* I. POP 1968
Ass. *Acino-Galietum anisophylli* BELDIE 1967
Ord. *Androsacetalia alpinae* BR.-BL. in BR.-BL. et JENNY 1926
All. *Veronicion baumgartenii* COLDEA 1991
Ass. *Poo contractae-Oxyrietum digynae* HORV. et al. 1937
Ass. *Saxifrago bryoidis-Silenetum acaulis* BOŞCAIU, TĂUBER et COLDEA 1977
Cls. Salicetea herbaceae BR.-BL. 1948
Ord. *Salicetalia herbaceae* BR.-BL. in BR.-BL. et JENNY 1926
All. *Salicion herbaceae* BR.-BL. in BR.-BL. et JENNY 1926
Ass. *Salicetum herbaceae* RÜBEL 1911 EM. 1933
Ass. *Soldanello pusillae-Ranunculetum crenati* (BORZA 1931) BOŞCAIU 1971
Ass. *Polytrichetum sexangularis* BR.-BL. 1926
Ord. *Arabidetalia coeruleae* RÜBEL ex BR.-BL. 1948
All. *Salicion retusae* HORV. 1949
Ass. *Salicetum retuso-reticulatae* BR.-BL. 1926
Cls. Juncetea trifidi (KLIKA et HADAČ 1944 p.p.)
Ord. *Caricetalia curvulae* BR.-BL. in BR.-BL. et JENNY 1926
All. *Caricion curvulae* BR.-BL. in BR.-BL. et JENNY 1926
Ass. *Primulo-Caricetum curvulae* BR.-BL. 1926 EM. OBERD. 1957
Cls. Scheuchzerio-Caricetea nigrae (NORDH. 1937) TX. 1937
Ord. *Caricetalia nigrae* KOCH 1926 EM. NORDH. 1937
All. *Caricion nigrae* KOCH. 1926 EM. KLIKA 1934
Ass. *Sphagno-Caricetum rostratae* STEFFEN 1931

DISCUSSIONS

Ass. *Acino-Galietum anisophylli* BELDIE 1967

Unsteady small debris slopes situated on the sunny side of the cirque on the southern slope of Galbena Mountain are populated by small areas of endemic plant formations of this association. The accumulation of snow during winter provides an increase of moisture in the growing season. *Acinos alpinus* ssp. *alpinus* is characteristic and sometimes edification species. In the floristic composition, in addition to the species belonging to the order *Thlaspietalia*, many species are of the order *Seslerietalia*, which indicates the direction of development of unsteady calcareous vegetation to grasslands on limestone substrate with fallow (Table 1). Besides the two characteristic species *Acinos alpinus* ssp. *alpinus* and *Galium anisophyllum*, there are almost always present species like *Senecio rupestris, Rhodiola rosea, Achillea schurii, Thymus pulcherrimus, Saxifraga moschata, Myosotis alpestris.*

Ass. *Poo contractae-Oxyrietum digynae* HORV., PAWL., WAL. 1937

The characteristic phytocoenosis for this Balkan association is poorly developed on mobile or fixed debris on the southern slope of Moldoveanu cirque. Characteristic species and edifying for this association are *Poa cenisia* ssp. *contracta* and *Oxyria digyna* (Table 2).

Ass. *Saxifrago bryoidis-Silenetum acaulis* BOŞCAIU, TĂUBER et COLDEA 1977

The areas affected by disaggregation within Moldoveanu cirque, where large amounts of snow accumulates in winter, are populated by phytocoenosis association. The coenoses *Silene acaulis* and *Saxifraga bryoides* are characteristic and edifying (Table 3).

Ass. *Salicetum herbaceae* RÜBEL 1911 EM. 1933

Hydrophilic plant formations of this association vegetate in the nivation niches or small depressions, in the glacial cirques from Moldoveanu and Galbena mountains, where the snow persists late in summer. The soil has high humidity and is shallow, rocky. Characteristic species and edifying for this association are *Salix herbacea* and *Soldanella pusilla* (Table 4).

Ass. *Soldanello pusillae-Ranunculetum crenati* (BORZA 1931) BOŞCAIU 1971

Unsteady and movable small debris in the investigated area is often populated by the association *Soldanello pusillae - Ranunculetum crenati*. It is a chiono-petrophilous Daco-Balkan association, of mesophilic nature, which grows mainly in places where we find stagnant snow for a long time, but drained after melting, located on sheltered slopes. Characteristic species *Ranunculus crenatus* and *Soldanella pusilla* are accompanied by species such as: *Primula minima, Plantago gentianoides, Cerastium cerastoides, Gnaphalium supinum,* etc. (Table 5).

Table 1. Ass. *Acino-Galietum anisophylli* BELDIE1967.
Tabel 1. Asociaţia *Acino-Galietum anisophylli* BELDIE 1967.

No. of relevée	**1**	**2**	**3**	**4**	**5**
Altitude	1800	1800	1900	1900	1900
Slope (degrees)	45	45	30	30	30
Exposure	S	S	S-E	S-E	S-E
General coverage (%)	45	30	25	30	45
Surface of relevée (sq.m.)	4	4	25	4	4
Char. ass.					
Acinos alpinus ssp. *alpinus*	2	2	1	2	2
Cerastium arvense	2	1	1	1	2
Papavero-Thymion* et *Thlaspietalia					
Galium anisophyllon	+	1	1	1	1
Thymus pulcherrimus	+		+	+	
Senecio rupestris	.	.	+	+	.
Sedum atratum	+	+			+
Potentiletalia caulescentis s.l.					
Asplenium viride		+	.	+	.
Cystopteris fragilis		+	+		+
Seslerietalia s.l.					
Achilea schurii	1	+	+	.	+
Myosotis alpestris	+	+	+	+	+
Scabiosa lucida	.	.	+	+	.
Saxifraga moschata	+	+	.	+	+
Carduus kerneri	+	+	+	+	+
Variae Syntaxa					
Alchemilla xanthocchlora	.	.	+	.	+
Rhodiola rosea	+	+	.	+	+
Poa granitica	+	+	1	+	.
Saxifraga aizoides	.	+	.	.	+
Taraxacum alpinum	+	.	+	+	.
Silene acaulis	.	+	.	.	+

Place and date of survey – Galbena Mountain, July 2010

Table 2. Ass. *Poo contractae-Oxyrietum digynae* HORV., PAWL., WAL. 1937.
Tabel 2. Asociaţia *Poo contractae-Oxyrietum digynae* HORV., PAWL., WAL. 1937.

No. of relevée	**1**	**2**	**3**	**4**
Altitude	2100	2150	2100	2100
Slope (degrees)	30	45	30	30
Exposure	S	S-E	S	S
General coverage (%)	30	40	25	30
Surface of relevée (sq.m.)	4	4	4	4
Char. ass.				
Poa cenisia sp. *contracta*	1	2	1	1
Oxyria digyna	2	2	1	2
Thalaspietea rotundifolii				
Arabis alpina	+	.	+	+
Saxifraga moschata	+	+	.	
Artemisia eriantha		+	+	
Salicetalia herbaceae s.l.				
Luzula alpinopilosa	+	.	+	+
Soldanella pusilla	+	+	1	+
Ranunculus crenatus	+	+	1	+
Cerastium cerastoides		+	+	+
Gnaphalium supinum	.	+		+
Sedum alpestre	+	+		
Variae Syntaxa				
Saxifraga androsacea	+	.	.	+
S. aizoides	.	+	+	+
Senecio carpaticus	+	.	+	.
Achillea schurii	+	+	+	+
Poa alpina	+	+	+	.
Silene pusilla	.	+	.	+

Place and date of survey – Moldoveanu Lake, July 2010.

Table 3. Ass. *Saxifrago bryoidis-Silenetum acaulis* BOŞCAIU, TAUBER et COLDEA 1977.
Tabel 3. Asociația *Saxifrago bryoidis-Silenetum acaulis* BOŞCAIU, TAUBER et COLDEA 1977.

No. of relevée	**1**	**2**	**3**	**4**
Altitude	2150	2100	2100	2100
Slope (degrees)	30	30	30	30
Exposure	S	S-V	S-V	S-V
General coverage (%)	30	40	20	30
Surface of relevée (sq.m.)	4	4	4	4
Char. ass.				
Silene acaulis	1	2	1	2
Poa cenisia ssp. *contracta*	+	+		+
Veronicion et ***Androsacetalia alpinae***				
Saxifraga bryoides	1	1	1	1
Veronica baumgartenii		+	+	.
Oxyria digyna			+	+
Thlaspietalia rotundifolii s.l.				
Saxifraga moscahta	+	+	.	.
Doronicum carpaticum		+	+	+
Salicetalia herbaceae s.l.				
Soldanella pusilla	1	+	+	+
Luzula alpinopilosa	+	.	+	+
Sedum alpestre	.	+	.	.
Chrysanthemum alpinum	1	1	+	+
Ranunculus crenatus	+	+	1	+
Variae Syntaxa				
Oreochloa disticha	+	.	+	.
Primula minima	+	1	+	+
Ligusticum mutellina	.	+	+	+
Cerastium alpinum	+	+	.	+
Potentilla aurea ssp. *chrysocraspeda*	1	+	+	+
Hieracium alpinum	.	.	+	+
Polygonum viviparum	+	+	.	
Geum montanum		.	+	.
Poa alpina	.	+	.	+
Juncus trifidus	+	.	+	.
Myosotis alpestris	+	+	.	+

Place and date of survey – Moldoveanu Lake, July 2010.

Table 4. Ass. *Salicetum herbaceae* BR.-BL. 1913.
Tabel 4. Asociația *Salicetum herbaceae* BR.-BL. 1913.

No. of relevée	**1**	**2**	**3**	**4**	**5**
Altitude	1900	1900	2000	2100	2000
Slope (degrees)	15	15	30	15	30
Exposure	N	N	N-V	N	N-V
General coverage (%)	40	30	25	20	25
Surface of relevée (sq.m.)	4	4	4	4	4
Char. ass.					
Salix herbacea	3	2	2	1	2
Soldanella pusilla	+	1	+	1	+
Salicion et ***Salicetalia herbaceae***					
Luzula alpinopilosa	.	+	+	.	+
Ranunculus crenatus	+	+	+	+	+
Gnaphalium supinum	+	.	.	+	+
Plantago gentianoides	.	+	+	+	.
Chrysanthemum alpinum	+				+
Salicetea herbaceae					
Cerastium cerastoides	+	+	+	1	+
Veronica alpina	.	+	.	+	+
Sedum alpestre	+		+		
Variae Syntaxa					
Primula minima	+	+	+	+	.
Ligusticum mutellina	.	+	.	+	+
Festuca airoides	+	.	+	+	.
Carex curvula	+	+		.	+
Campanula alpina	+	.	.	+	+
Homogine alpina	.	+	+	.	+
Juncus trifidus	+	+	.	+	.

Place and date of survey – 1-2, Galbena Mountain, July 2010; 3-5, Moldoveanu Mountain, July 2010.

Table 5. Ass. *Soldanello pusillae-Ranunculetum crenati* (BORZA 1931) BOŞCAIU 1971.
Tabel 5. Asociaţia *Soldanello pusillae-Ranunculetum crenati* (BORZA 1931) BOŞCAIU 1971.

No. of relevée	**1**	**2**	**3**	**4**	**5**
Altitude	2000	2100	2200	2200	2200
Slope (degrees)	15	30	30	30	15
Exposure	N	N-E	N-E	N	N-E
General coverage (%)	65	40	30	65	60
Surface of relevée (sq.m.)	4	4	4	4	4
Char. ass.					
Soldanella pusilla	3	2	2	3	3
Ranunculus crenatus	2	2	1	2	2
Salicion* et *Salicetalia					
Plantago gentianoides	1	+	+	1	+
Gnaphalium supinum	+	.	+	+	+
Primula minima	+	+	+	.	+
Carex pyrenaica	.	.	+	+	+
Geum montanum	+	+		+	.
Luzula alpinopilosa		+		+	+
Salicetea herbaceae					
Sedum alpestre	+		+		+
Taraxacum alpinum	+	.	+		.
Cerastium cerastoides		+	+		+
Variae Syntaxa					
Ligusticum mutellina	+	+	+	.	+
Agrostis rupestris	.	.		+	.
Poa alpina	+	+		.	+
Veratrum album	+	.	.	+	+
Achillea schurii	.	+	+		+
Deschampsia caespitosa	+	+	.	.	+
Campanula alpina	+	.	+	+	.

Place and date of survey – Moldoveanu Mountain, July 2010.

Ass. *Polytrichetum sexangularis* BR.-BL. 1926

Chionophilous coenoses of this association are found sporadically in the nivation niches on the north side of Moldoveanu lake cirque where snow is stagnant until early summer. The characteristic species of the association is *Politrichum sexangulare*. In this association other, there are found other species of moss such as *Dicranum scoparium* and *Mnium splendens*. Few species found in this association are chionophilous cormophyta species (Table 6).

Table 6. Ass. *Polytrichetum sexangularis* BR.-BL. 1926.
Tabel 6. Asociaţia *Polytrichetum sexangularis* BR.-BL. 1926.

No. of relevée	**1**	**2**	**3**
Altitude	2100	2150	2150
Slope (degrees)	30	45	30
Exposure	N	N	N-E
General coverage (%)	50	70	60
Surface of relevée (sq.m.)	4	4	4
Char. ass.			
Polytrichum sexangulare	3	3	3
Salix herbacea	1	2	1
Salicion* et *Salicetalia herbaceae			
Luzula alpinopilosa	1	1	1
Ranunculus crenatus	+	1	1
Plantago gentianoide	+	+	.
Carex pyrenaica	.	+	+
Gnaphalium supinum	+	+	+
Salicetea herbaceae			
Sedum alpestre	+		+
Veronica alpina	.	.	+
Cerastium cerastoides	+	+	+
Variae syntax			
Primula minima	+	+	.
Deschampsia caespitosa	+	+	+
Geum montanum	+	.	.
Carex curvula	.	+	+
Poa alpine	+	+	
Taraxacum nigriscens	.	+	.
Ligusticum mutellina	+	.	+

Place and date of survey – Moldoveanu Lake, July 2010.

Ass. *Salicetum retuso-reticulatae* BR.-BL. 1926

On limestone slopes of Galbena Mountain there are met chionophilous coenoses enlightened by *Salix reticulata* and *S. retusa*, which live with *Dryas octopetala.* Dominant species *S. retusa* vegetate with: *Polygonum viviparum, Silene acaulis, Ranunculus oreophillus, Primula minima, Juncus trifidus, Carex sempervirens*, etc. Floristic diversity of these conenoses is very large (Table 7).

Table 7. Ass. *Salicetum retuso-reticulatae* BR.-BL. 1926.
Tabel 7. *Asociaţia Salicetum retuso-reticulatae* BR.-BL. 1926.

No. of relevée	**1**	**2**	**3**	**4**	**5**
Altitude	2200	2200	2100	2100	2150
Slope (degrees)	40	40	35	35	40
Exposure	S	S	S-V	S-V	S-V
General coverage (%)	40	45	60	60	40
Surface of relevée (sq.m.)	4	4	4	4	4
Char. ass.					
Salix retusa	2	2	2	2	1
S. reticulata	2	2	3	3	2
Salicetalia herbaceae					
Salix herbacea	+	.	.	+	+
Luzula alpinopilosa		+	+	+	
Seslerietalia					
Dryas octopetala	+	1	+	+	1
Myosotis alpestris	.	.	+	+	.
Carex sempervirens	+	+	+		+
Saxifraga moschata					
Polygonum viviparum	+	+	+	.	+
Silene acaulis	+	+	.	+	+
Ranunculus orephilus	.	+	+	+	.
Cerastium transsilvanicum	+	.	+	.	+
Saxifraga adscendens	.	+	.	+	.
Armeria alpina	+		+	+	+
Variae Syntaxa					
Campanula alpina	.	+	+	.	+
Primula minima	+	.	.	+	+
Doronicum carpaticum	+	+	+	.	1
Festuca airoides	.	+	.	+	
Veronica baumgarteni	+		+	+	.
Huperzia selago	+	.	+		+
Gentiana verna	.	+	.	.	+
Soldanella pusilla	+	.	+	+	.
Ligusticum muttelina	+	+	.		+
Potentilla aurea ssp. *chrysocraspeda*	+	.	+	.	.

Place and date of survey –Galbena Mountain, July 2010.

Ass. *Primulo-Caricetum curvulae* BR.-BL. 1926 EM. OBERD. 1957

This association is found both in the glacial cirque of Moldoveanu lake and on the wind exposed slopes of Galbena Mountain, where snow persists until late spring. The characteristic species of this association is *Carex curvula*, which carries 60 to 80% coverage. Other species found in the association are: *Festuca airoides, Potentilla aurea* ssp. *chrysocraspeda, Primula minima, Campanula alpina, Hieracium alpinum*, mosses and lichens (Table 8).

Ass. *Sphagno-Caricetum rostratae* STEFFEN 1931

The conenoses of this association are met on the bog soil, which is very rich in organic substances and very humid. It`s reaction is very acid. The edifications species of this association are *Sphagnum recurvum* and *Carex rostrata.*

Table 8. Ass. *Primulo-Caricetum curvulae* BR.-BL. 1926, EM. OBERD. 1957.
Tabel 8. Asociaţia *Primulo-Caricetum curvulae* BR.-BL. 1926, EM. OBERD. 1957.

No. of relevée	**1**	**2**	**3**	**4**	**5**
Altitude	2100	2100	2150	2100	2100
Slope (degrees)	30	30	15	45	45
Exposure	S	S-V	S-V	N-V	N
General coverage (%)	65	50	60	40	50
Surface of relevée (sq.m.)	4	4	4	4	4
Char. ass.					
Carex curvula	3	3	3	2	3
Primula minima	2	1	2	2	1
Caricion et Caricetalia curvulae					

Campanula alpina	1	+	1	+	+
Festuca airoidis	+	1	+	+	+
Agrostis rupestris	+	+	.	.	+
Primula minima	+	+	+	+	.
Sesleria coerulans	.	+		.	+
Phyteuma nanum	+		.	+	+
Luzula spicata	.	.	+	+	
Oreochloa disticha	+	+			
Juncetea trifidi					
Juncus trifidus	+	.	+	+	.
Hieracium alpinum	+	+	+	.	+
Pulsatilla alba	.			+	+
Minuartia sedoides	+			+	
Variae Syntaxa					
Deschampsia flexuosa	.	+	+	.	+
Polygonum viviparum	+	.	+	+	
Anthemis carpatica	+	+	+	.	.
Poa alpina	.		.	+	+
Dianthus glacialis	+	.	+	.	+
Silene acaulis	+	+	.	+	+
Potentilla ternata	+	+	+		.
Ligusticum mutellina	.	.	+	.	+
Pedicularis verticillata	+	+	.	+	.

Place and date of survey – 1-3, Moldoveanu Lake, July 2010; 4-5, Galbena Mountain, July 2010.

Table 9. Ass. *Sphagno-Caricetum rostratae* STEFFEN 1931.
Tabel 9. Asociaţia *Sphagno-Caricetum rostratae* STEFFEN 1931.

No. of relevée	**1**	**2**	**3**	**4**
Altitude	2000	2000	2100	2000
Slope (degrees)	10	15	10	10
Exposure	S	S	S	S
General coverage (%)	65	80	65	60
Surface of relevée (sq.m.)	4	4	4	4
Char. ass.				
Sphagnum recurvum	3	3	2	3
Carex rostrata	2	3	3	2
Caricion et Caricetalia				
Carex echinata	1	+	1	+
Juncus triglumis	+	.	+	+
Cyperus fuscus	.	+	+	.
Epilobium palustre	+	+	.	+
Luzula spadicea	+		+	+
Sphagnetalia				
Eriophorum vaginatum	+	+	+	.
Polytrichum commune		+	+	+
Calthion				
Caltha palustris	+	+	.	+
Myosotis palustris	+	+	+	+
Crepis paludosa			+	+
Variae Syntaxa				
Luzula sudetica	+	.	.	
Nardus stricta		+	+	.
Ranunculus repens	.	+	+	+
Homogyne alpina	+	+	.	+
Carex bryzoides	+	.	+	.
C. pallescens	.	+	.	+
Sphagnum palustrre	+	+	+	.

Place and date of survey –Moldoveanu Lake, July 2010.

CONCLUSIONS

There have been identified phytocoenoses belonging to nine associations. The area has been less studied, so we decided to start research in the summer of 2010. We will make a study over the communities settled down in and around the peat bog during the summer of 2011.

REFERENCES

BRAUN-BLANQUET J. 1964. *Pflanzensoziologie. Grundzüge der Vegetations-kunde.* Ed. 3. Springer-Verlag. Wien-New York. 865 pp.

CIOCÂRLAN V. 2000. *Flora ilustrată a României. Pteridophyta et Spermatophyta.* Ediția a doua revăzută și adăugită. Edit. Ceres. Bucureşti. 1138 pp.

COLDEA GH. 1991. *Prodrome des associations végétales des Carpates du sud-est (Carpates Roumaines).* Camerino: Docum. Phytosoc. Npuv. Sér. **13**: 317-539.

FLOREA M. 1998. *Munții Făgărașului. Studiu geomorfologic.* Edit. Foton. Braşov. 114 pp.

PIŞOTA I. 1971. *Lacurile glaciare din Carpații Meridionali.* Studiu hidrologic. Edit. Academiei Bucureşti. 520 pp.

SANDA V., POPESCU A., BARABAŞ N. 1998. *Cenotaxonomia şi caracterizarea grupărilor vegetale din România.* Studii şi Comunicări. Muzeul de Ştiințele Naturii Bacău. Edit. „I. Borcea". Bacău. **14**: 1-366.

SANDA V., POPESCU A., STANCU DANIELA-ILEANA. 2001. *Structura cenotică şi caracterizarea ecologică a fitocenozelor din România.* Edit. Conphis. Râmnicu Vâlcea. 359 pp.

***. 2009. *Flora Europaea.* http://rbg-web2.rbge.org.uk/FE/fe.html (accesed to April 03, 2011).

Stancu Daniela Ileana
Argeş County Museum, A. Călinescu Str., No. 44, Piteşti, Romania
E-mail: stancuileana@yahoo.com

Received: March 31, 2011
Accepted: August 9, 2011

RARE SPECIES OF ORTHOPTERA (INSECTA) FROM THE REPUBLIC OF MOLDOVA

STAHI Nadejda, DERJANSCHI Valeriu

Abstract. In the article it is discussed the Orthoptera conservation in the Republic of Moldova, especially those from subfamily Saginae – *Saga pedo* (PALLAS, 1771) and Tettigoniinae – *Gampsocleis glabra* (HERBST, 1786) and *Onconotus servillei* (FISCHER VON WALDHEIM, 1846). The *Saga pedo* is considered one of the largest insect of Europe. Its exclusive carnivorous diet and parthenogenetic reproduction makes it an exceptional orthopter. In 2005-2010, the authors found *Saga pedo*, *Gampsocleis glabra* and *Onconotus servillei* only in two localities: village Slobozia-Dushca and "Bugeac" Natural Reserve. These species are vulnerable not just for the Republic of Moldova but for Europe too (all are included in different Red Lists as an endangered or critically endangered species). Also, there are data concerning habitat choice, accompanying species, abundance and phenology of these grasshoppers.

Keywords: Republic of Moldavia, Saginae, Tettigoniinae, Red List, endangered.

Rezumat. Specii rare de ortoptere (Insecta) din Republica Moldova. În lucrare este discutată conservarea ortopterelor (Orthoptera) în Republica Moldova, în special a celor din subfamiliiile Saginae – *Saga pedo* (PALLAS, 1771) şi Tettigoniinae – *Gampsocleis glabra* (HERBST, 1786) şi *Onconotus servillei* (FISCHER VON WALDHEIM, 1846). Specia *Saga pedo* este considerată una dintre cele mai mari insecte din Europa. Specie exclusiv carnivoră şi cu reproducere partenogenetică, face ca acest orthopter să fie excepţional. Pe parcursul anilor 2005-2010 speciile au fost semnalate doar în două localităţi: comuna Slobozia-Duşca şi Rezervaţia Naturală „Bugeac". Speciile citate sunt rare nu numai în Republica Moldova, ci şi în Europa (toate fiind incluse în diferite Liste Roşii, având statut pe cale de dispariţie sau critic periclitată). De asemenea, lucrarea include date privind particularităţile bio-ecologice ale speciilor.

Cuvinte cheie: Republica Moldova, Saginae, Tettigoniinae, Listă Roşie, dispariţie.

INTRODUCTION

All species and the communities that they compose are increasingly threatened by human disturbance, habitat loss and extirpation. Orthoptera are no exception. Around the world, at least four orthopteran species have already been lost (HOEKSTRA, 1998). The 1996 Red List of Threatened Animals (IUCN, 1996) includes 66 orthopteran species classified as critically endangered, endangered or vulnerable, while three more are considered to be conservation dependent. Species on this list are found in over 25 countries across Europe, Asia, Australia and North America. Additional species may be threatened in Africa and South America but we lack documentation of their status. Preservation of these and other Orthoptera will require effective conservation (HOEKSTRA, 1998).

MATERIAL AND METHODS

The investigations were done in different sectors of the Republic of Moldova, especially steppe sectors, from 2004 till 2008. Investigations were mainly made in summer months – June-August in the "Bugeac" Natural Reserve, which is a botanical reserve, situated in the south-east of our Republic between Bugeac and Cicur-Mingir villages, Cimishlia district. The species of Orthoptera order were not collected; they were investigated in the field only; we have also taken photos of this species. The identification of the species was made according to: KNECHTEL & POPOVICI-BÎZNOSEANU (1959), IORGU & IORGU (2008).

RESULTS AND DISCUSSIONS

Until now, in the Republic of Moldova, there was only one bush cricket, *Saga pedo*, included in the Red Book (2002). In the last several years, we discovered two new rare species, which are included in the European national Red List as an endangered or critically endangered species (ANDREEV et al., 2007; STAHI, 2008).

As a result of the investigations we have established that on the territory of the Republic of Moldova three species, which belong to Orthoptera order (Insecta), have statutes as an endangered or critically endangered species. Those species are from the subfamilies Saginae – *Saga pedo* (PALLAS, 1771), Tettigoniinae – *Gampsocleis glabra* (HERBST, 1786) and *Onconotus servillei* (FISCHER VON WALDHEIM, 1846).

Saga pedo is included in the Red Book of the Republic of Moldova; *Gampsocleis glabra* is a new species for the fauna of the republic; furthermore, in Europe, all the three species have the status of very rare and protected species by European laws (IUCN, 1996, 2006).

Onconotus servillei and *Gampsocleis glabra* were observed in the "Bugeac" Nature Reserve, but the specimens of this species were not collected. The authors had to collect the species *Saga pedo* and *Onconotus servillei* from the "Bugeac" Nature Reserve (ANDREEV et al., 2007; STAHI, 2009), but during the four years of our researches, only in the summer of 2008 we observed one of these two species – *Onconotus servillei*.

All three are xerophilous and praticolous species that prefer steppe vegetations, where the height of the herbal layer is higher than 30 cm and even more. In these biotopes, steppe vegetations prevail such as: *Poa angustifolia, Bromopsis inermis, Elytrigia repens, Eremopyrum triticeum, Festuca valesiaca, Stipa capillata, Taraxacum officinale,* and others; and shrubs *Thumus marschallianus, Crataegus curvisepala, Rosa spinossima* and *Rosa pratensis*, etc. (POSTOLACHE, 1995).

The *Saga pedo* (Fig. 1), *Onconotus servillei* (Fig. 2), and *Gampsocleis glabra* (Fig. 3), can be met along with other typical grasshoppers for the steppe vegetation: *Phaneroptera falcata, Tettigonia viridissima, Platycleis vittata, P. tesselata, P. intremedia, Gryllus campestris, Melanogryllus desertus, Oecanthus pellucens, Calliptamus italicus, Oedaleus decorus, Oedipoda caerulescens, Dociostaurus brevicollis, Stenobothrus lineatus, Omocestus viridulus, O. rufipes, O. haemorrhoidalis, O. minutus, Myrmeleotettix maculatus, Chorthippus brunneus, Ch. bigutullus, Ch. mollis, Ch. albomarginatus, Ch. loratus, Euchorthippus pulvinatus, E. declivius* and others.

Description, distribution, phenology, habitat and the way of life of the three species will be given below.

Saga pedo (PALLAS, 1771)

Nomenclature: family Tettigoniidae KRAUSS, 1902; subfamily Saginae BRUNNER VON WATTENWYL, 1878 genus Saga CHARPENTIER, 1825.

Scientific synonyms: *Gryllus giganteus* VILLERS, 1789; *Gryllus pedo* PALLAS, 1771; *Locusta serrata* FABRICIUS, 1793; *Saga italica* COSTA, O.G. & A. COSTA, 1871; *Saga nudipes* FISCHER VON WALDHEIM, 1830; *Saga serrata* (FABRICIUS, 1793); *Saga vittata* FISCHER VON WALDHEIM, 1830.

Description: The body has a cylindrical form and is very long: it ranges between 50 and 70 mm and the ovipositor's length is about 35-40 mm. The adult female has an obtuse head and the antennae are threadlike and longer than the body. The body may be of green or brown with yellow lines situated on the lateral parts of the body that starts from the lateral borders of the pronotum and continues on the abdomen. The tibias of the first and second pair of legs have two rows of 10-11 thorns for each row on the lower parts; these thorns are adapted for catching insects which they devour. The insect has the tympanum located on the fore tibia. The hind legs are not adapted for jumping and are endowed with two spurns on the inferior pats of tibias. The previous and hind wings are much reduced, sometimes they are absent. Subgenital plate of the female is triangular with a small incision in the apex. The ovipositor is very long, straight and denticulate in the apical region.

In her work, OLMO-VIDAL (2007) described the male of *Saga pedo* that has a very short tegmen reduced to the stridulatory organs; in contrast, the females do not have tegmen.

Habitat: The steppe biotopes are specific for *Saga pedo.*

Life history, food and feeding: *Saga pedo* is an obligatory parthenogenetic species of Orthoptera and is therefore able to produce off spring without any fecundation. This is a tetraploid species and has 68 chromosomes. The females begin to lay eggs about 3-4 weeks after moulting of imagos, in late summer, especially in day-time. Eggs are planted deep in the soil by means of long sabre-like ovipositor. The females lay 7-8 eggs only. The larvae appear in spring and they have 8 stadia. Adults appear in July and can be observed till September.

Saga pedo is an obligatory parthenogenetic xerotermophilous and praticolous insect. This is a nocturne, predatory insect, which with its thorns of fore and middle pairs of legs catches and devours different insects of smaller size- Bush-crickets, grasshoppers, Mantids and others.

Distribution: this is a Central Asian – South-European species distributed from Portugal in the west, to Western Siberia in the east and Sicily in the south – its northern boundary runs across the Czech Republic and Slovakia (HELLER, 2004). So, it is present in more than 20 countries from Europe and Asia, such as: Armenia, Austria, Azerbaijan, Bulgaria, China, the Czech Republic, France, Georgia, Germany, Hungary, Italy, Kazakhstan, Kyrgyzstan, Romania, Russia, Serbia and Montenegro, Slovakia, Spain, Switzerland, Tajikistan, Turkmenistan, Ukraine and Uzbekistan (HELLER, 2004).

Range: in the Republic of Moldova *Saga pedo* was registered in the 20th century only. The first data on this species in our republic were published by MALICHENKOVA (1983), later, NECULISEANU et al. (1992) and since 1992, this species is included in the List of rare and endangered species of insects from the Republic of Moldova.

For a long period of time (fifteen years) this species was not found on the territory of the republic. In the summer of 2007 five females were found in the village Slobozia-Dushca, Criuleni district, from the central part of the republic. The females were observed on the terrain with steppe vegetation with more than 3 hectares (STAHI, 2008).

Status: the bush-cricket – *Saga pedo* is a very rare and vulnerable species which is included in Red Books of diverse countries and in 2006 IUCN Red List of Threatened Species (IUCN, 2006).

Key sites: *Saga pedo* was observed in village Slobozia-Dushca, Criuleni district.

Onconotus servillei (FISHER VON WALDHEIM, 1846)

Nomenclature: family Tettigoniidae KRAUSS, 1902, subfamily Tettigoniinae KRAUSS, 1902.

Scientific synonyms: *Onconotus crassicaudus* IVANOV, 1888.

Life history/food and feeding: this is a phytophagous, geophilous and praticolous species;

Distribution: *Onconotus servillei* is a Central Asian-Pontic species present in Bulgaria, Hungary, Romania, Central Russia, East and South Russia, Ukraine, Yugoslavia inclusive Serbia, Kosovo, Vojvodina, Montenegro, Asiatic Turkey, Caucasian Russian Republics, Georgia, Armenia, Azerbaijan, Lebanon, Syria, Israel, Jordan, Sinai Peninsula (Egypt), Arabian Peninsula, Iran, Iraq (HELLER, 2004).

Status: In Romania it is a very rare species and is protected (IORGU & IORGU, 2008). Furthermore, this species is included in IUCN Red List of Threatened Animals (IUCN, 1996, 2006).

Conservation: the *Onconotus servillei* is proposed to be included in the Red Book of the Republic Moldova.

Key sites: the *Onconotus servillei* was collected just in "Bugeac" Natural Reserve.

Conservation of *Saga pedo*, *Gampsolceis glabra* and *Onconotus servilei* requires the following needs:

- protection and the preservation of specific habitat of the species-steppe surfaces;
- reducing the treatments with chemical substances in steppe areas;
- prohibition of the collection made by the collectors;
- ban on grazing of sheep, goats and cows in the habitat of these species;
- research of distribution, biology and ecology of the species.

Figure 1. *Saga pedo* L. (♀) (original).

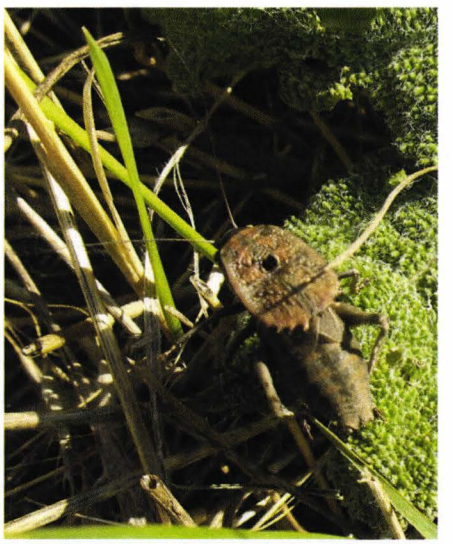


Figure 2. *Onconotus servillei* FICH. (♂) (original).

Figure 3. *Gampsocleis glabra* HERB. (♀) (original).

Gampsocleis glabra (HERBST, 1786)

Nomenclature: family Tettigoniidae KRAUSS, 1902, subfamily Tettigoniinae KRAUSS, 1902.

Scientific synonyms: *Decticus alberti* SEIDL, 1937, *Gampsocleis annae* SHUGUROV, 1908, *Gampsocleis podolica* SHUGUROV, 1908, *Locusta glabra* HERBST, 1786, *Locusta prima* SCHAFF, 1776.

Biology: adults can be seen from June till August.

Habitat: this species lives hidden in bushes and in grassland where the height of grasses reaches about 40-60 cm.

Description: The body length of *Gampsocleis glabra* is about 20-26 mm and the ovipositor of the female is 15-22 mm, and it is notched on the apex. The body of the specimens belonging to this species is green or brown-yellow; moreover, on its body there can very well be seen a lot of dark or brown spots. The pronotum of the insect has two stripes, white and black. The femurs of posterior legs have two longitudinal stripes. The fore wings are green and the hind ones are transparent. The dorsal part of the abdomen is green or yellow, and the abdominal sites with dark stripes ventral yellow.

Distribution: Bush cricket *Gampsocleis glabra* is a Central Asian – South European species. This species is included in the European national Red Lists as an endangered or critically endangered species in Austria (BERG & ZUNA-

KRATKY, 1997), Germany (MAAS et al., 2002), Poland (LIANA, 2007), Slovakia (KRIŠTÍN, 2007). Also, this species is rare in Romania and very rare in Moldavia (Romania) and is spread especially between the Siret and the Prut rivers (IORGU, 2008).

A brilliant work on the distribution and ecology of *Gampsocleis glabra* has been written by A. KRISTIN et al. (2007). In this paper, they have shown that *Gampsocleis glabra* in Central Europe reaches actually the northern edge of its range in Poland and it is extinct in the Czech Republic (BAZYLUK & LIANA, 2000). The distribution of this species in the northern area was analysed by several authors in the last decade (BAZYLUK & LIANA, 2000; KRIŠTIN & ZACH 1997; KRIŠTIN et al., 2004; MAAS et al., 2002).

Habitat: for this reason, we can consider it as a thermophilous species, with affinity to xeric vegetation (STAHI, 2009). Considering the height of the herbal layer, the species prefers grassy stands taller than 50 cm (Fig. 3).

Life history/food and feeding: *Gampsocleis glabra* is an insectivorous, praticolous, xerophilous, thermophilous and stenotopic species.

Status: the *Gampsocleis glabra* is proposed to be included in the Red Book of the Republic Moldova.

Key sites: the *Gampsocleis glabra* was collected just in "Bugeac" Natural Reserve.

CONCLUSIONS

Saga pedo, Onconotus servillei Gampsocleis glabra species are proposed to be included the third edition of the Red Book of the Republic Moldova. The *Gampsocleis glabra* is a new species for the fauna of the Republic of Moldova.

REFERENCES

ANDREEV A., ŞABANOVA G., ŢURCANU V., IZVERSKAIA T., GORBUNENKO P. 2007. *Stepnyie ekosistemy nijnego Dnestra.* Buletinul Ştiinţific. Revistă de Etnografie, Ştiinţe ale Naturii şi Muzeologie. Chişinău. **4**(17): 160-174.

BAZYLUK W. & LIANA A. 2000. *Prostoskrzydłe – Orthoptera.* Muzeum i Instytut Zoologii PAN. Warszawa. 156 pp.

BERG H-M. & ZUNA-KRATKY T. 1997. *Heuschrecken und Fangschrecken. Eine Rote Liste der in Niederösterreich gefährdeten Arten.* Landesregierung. Wien. 112 pp.

HELLER K.-G. 2004. *Fauna Europaea: Ensifera, Caelifera.* Fauna Europaea version 1.1, http://www.faunaeur.org. (accessed: March 9, 2011).

HOEKSTRA J. 1998. *Conserving Orthoptera in the wild: lessons from Trimerotropis infantilis (Oedipodinae).* Journal of Insect Conservatio. **2**: 179-185.

IORGU I. & IORGU ELENA. 2008. *Bush-crickets and Grasshoppers from Moldavia (Romania).* Edit. Pim, Iaşi. 294 pp.

OLMO-VIDAL J. M. 2007. *Atlas of the Orthoptera of Catalonia.* Atlas of biodiversity. Barcelona. **1**: 337-458.

KAŇUCH P., BALLA M., GAVLAS V. 2007. *On distribution and ecology of Gampsocleis glabra and Tettigonia caudata (Orthoptera) in Slovakia.* Articulata: Faunistik. **22**(1): 1-9.

KNECHTEL W. & POPOVICI-BÎZNOŞEANU A. 1959. *Orthoptera: ordinele Saltatoria, Dermaptera, Blattodea, Mantodea în fauna României. Insecta.* Edit. Academiei R.P.R. Bucureşti. 7(4). 265 pp.

KRIŠTIN A. & ZACH P. 1997. *Rovnokrídlovce (Orthoptera) a modlivky (Mantodea) vybraných lokalít stredného Poiplia (južné Slovensko).* Urban, P. & Hrivnàk, R. (Eds.). Poiplie: 117-122.

KRIŠTIN A., GAVLAS V., BALLA M., KAŇUCH P. 2004. *Orthoptera and Mantodea of the East - Slovakian lowland (Východoslovenská nížina).* Folia Entomologica Hungarica. **65**: 159-170.

LIANA A. 2007. *Gampsocleis glabra (Herbst, 1786), Stepówka, Heath Bush-cricket.* In: Głowaciński, Z. & Nowacki, J., Polish Red Data Book of Animals – Invertebrates. Institute of Nature Conservation PAS. Kraków. 448 pp.

MAAS S., DETZEL P., STAUDT A. 2002. *Gefährdungsanalyse der Heuschrecken Deutschlands. Verbreitungsatlas, Gefährdungseinstufung und Schutzkonzepte.* Bundesamt für Naturschutz, Bonn-Bad Godesberg. 401 pp.

MALICENKOVA H. 1983. *Otryad pryamokrylyie Orthoptera.* In: Zhivotnyi mir Moldavii. Nasekomye. Izdatelistvo Shtiintsa. Kishinyov: 48-60 [In Russian].

NECULISEANU Z., STRATAN V., VEREŞCIAGHIN B., OSTAFICIUC V. 1992. *Insectele rare şi pe cale de dispariţie din Moldova.* Edit. Ştiinţa, Chişinău: 11-16.

POSTOLACHE G. 1995. *Vegetaţia Republicii Moldova.* Edit. Ştiinţa. Chişinău. 339 pp.

STAHI NADEJDA. 2008. *New record of Saga pedo (Pallas, 1771) (Orthoptera: Tettigoniidae, Saginae) from the Republic of Moldova.* The four scientific conference «Molodi ta postup biologhii». Livov. 303 pp.

STAHI NADEJDA. 2009. *Gampsocleis glabra a new species of Tettigoniinae (Insecta: Orthoptera) from the Republic of Moldova.* International Conference of Young researchers VII edition. Chişinău. 56 pp.

***. The Red Book of the Republic of Moldova. *Second edition.* 2002. Edit. Ştiinţa. Chişinău. 235 pp.

***. Red List of Threatened Animals. IUCN, 1996 // www.wcmc.org.uk/species/animals (accessed: March 9, 2011).

***. Red List of Threatened Species. IUCN, 2006 // www.wcmc.org.uk/species/animals (accessed: March 9, 2011).

Stahi Nadejda, Derjanschi Valeriu
Institute of Zoology A.S. of Moldova, Academy Str. 1
MD-2028, Kishinev, Republic of Moldova
E-mail: n_stahi@yahoo.com
E-mail: valder2002@yahoo.com

Received: March 30, 2011
Accepted: August 29, 2011

SEASONAL CHANGES IN ABUNDANCE AND DIVERSITY OF GROUND BEETLES (COLEOPTERA: CARABIDAE) IN TWO NATURAL HABITATS OF THE JAMAICA BAY WILDLIFE REFUGE

NECULISEANU Zaharia

Abstract. Spatial and temporal variation in the species composition, seasonal abundance and diversity of ground beetles were studied in two sites: wet meadow (site 1) and shrub thickets (site 2), both located in the Jamaica Bay Wildlife Refuge (Gateway National Recreation Area, New York). Ground beetles (Carabidae) were pitfall-trapped from May to October 2008. A total of 230 individuals of carabids representing 34 species were collected in the vegetative season, 91.2% of which represented autochthonous and 8.8% introduced species. Totals of 210 individuals representing 27 species and 20 beetles representing 11 species were trapped from site 1 and site 2, respectively. Harpalinae was the most abundant subfamily, with a total of 20 species: this subfamily contributed to 77.39% of all caught individuals. *Chlaenius sericeus* (FORSTER, 1771) was the most abundantly collected species from the site 1, and it was mostly trapped in spring and summer. *Calathus opaculus* LECONTE, 1854 was the abundantly species trapped from the site 2. The majority of carabids trapped from the site 1 belonged to species overwintering as adults, but those trapped from the site 2 belonged to species overwintering as larvae. Carabids activity culminated in site 1 in spring-summer, and decline in autumn, but in site 2 activity culminated in spring and autumn. The ratio of female to male in all carabids caught in the traps in both sites was 1.34:1. Species richness, number of specimens and diversity were much higher in site 1.

Keywords: Carabidae, diversity, seasonal abundance, sex ratio.

Rezumat. Dinamica activităţii sezoniere şi diversitatea carabidelor (Coleoptera: Carabidae) în două habitate naturale din Refugiul Natural Jamaica (JBWR). A fost cercetată compoziţia specifică, activitatea sezonieră şi diversitatea carabidelor din două habitate naturale: lunca umedă şi desiş de arbuşti, ambele situate în Refugiul Jamaica (Jamaica Bay Wildlife Refuge (Gateway National Recreation Area, New York). Carabidele au fost colectate cu ajutorul capcanelor Barber în perioada lunilor mai - octombrie, 2008. În total au fost capturaţi 230 indivizi, ceea ce reprezintă 34 specii, dintre care 91,2% au constituit specii autohtone (nearctice) şi 8,8% specii introduse europene sau eurosiberiene. În lunca umedă, în capcane au fost colectaţi 210 indivizi ce reprezintă 27 specii, în desişul de arbuşti, 20 indivizi ce reprezintă 11 specii. Subfamilia Harpalinae a fost cea mai abundentă, cu un total de 20 specii reprezentând 77,39% total indivizi capturaţi. În primul habitat *Chlaenius sericeus* (FORSTER, 1771) a fost cea mai abundentă specie şi s-a capturat în capcane (în special primăvara şi vara), iar în cel de-al doilea habitat, specia cea mai abundentă a fost *Calathus opaculus* LECONTE, 1954. Majoritatea carabidelor colectate în lunca umedă sunt specii ce iernează în stadiul de adult, iar în desişul de arbuşti, specii ce iernează în stadiul de larvă. În lunca umedă, vârful de activitate a adulţilor a fost cea mai mare în perioada de primăvară-vară, cu activitate scăzută în toamnă, în timp ce în desişul de arbuşti cea mai intensă activitate a adulţilor s-a observat primăvara şi toamna. Raportul femelelor faţă de masculi (sex ratio) a tuturor carabidelor capturate în capcanele Barber din ambele habitate a fost 1,34:1. Bogăţia specifică, numărul de indivizi şi diversitatea, au fost în general mai mari în lunca umedă.

Cuvinte cheie: Carabidae, diversitate, abundenţă sezonieră, raportul sexelor.

INTRODUCTION

The Jamaica Bay Wildlife Refuge (JBWR), a unit of Gateway National Recreation Area, is one of the most important urban wildlife refuges in the USA, and is the largest bird sanctuary in the northeastern United States. Encompassing 3.662 ha it is comprised of diverse habitats including open fields, shrub thickets and developing woodlands, wet meadows and salt marshes, several fresh and brackish water ponds and an open expanse of bays and islands - all located within the limits of New York City. More than 325 species of birds have been recorder here during the last 25 years.

In the Jamaica Bay region there have been observed 69 species of butterflies (Lepidoptera) restricted to one or more habitat types (INGRAHAM et al., 1989), but generally, little is known about the insects of this area. The objectives of this study were to 1) evaluate the seasonal activity patterns of carabids in two habitats (wet meadow, shrub thickets) by using pitfall traps and to examine the factors influencing their peak of activity; 2) investigate the richness and diversity of carabid species during the research period in both sites in each season (Simpson's and Shannon's diversity indices, and equitability); 3) estimate the abundance and population structure of ground beetles in three sampling periods in two different habitats, located in the JBWR.

MATERIAL AND METHODS

Both study sites were established in the East Pond of JBWR, located on the east side of Cross Bay Boulevard, Queens, NY. The site 1 was a wet meadow. We have chosen this site as an open habitat, consisting of small herbaceous plants with few vertical plant components, predominantly the reed growing along water shores. The soil consists of organic matter, sand, gravel and it was permanently moist. The site 2 was selected as a shrub thicket. This type of habitat was semi-open, consisting of many species of herbaceous plants, bushes and some scarcely growing trees. The

soil was sandy and permanently dry during the growing season. The surface of soil was covered by a thin layer of leaf-litter.

The Carabids were sampled in spring, summer, autumn by using pitfall traps consisting of plastic jars (08 cm diameter by 10 cm deep) buried in the ground even with the surface and filled with a solution of white vinegar (100 ml in each trap). In each habitat type 10 pitfall traps were installed in May, July and October.

The distance between the set traps was 10 m. The traps were exposed for 7 days in each of the above month (May, July, and October). All captured insects from the traps were transported in the laboratory and were washed, counted, separated by sex. Some manually collected individuals were preserved in 70% alcohol for further identification, but many species were kept in the laboratory in order to study their behaviour, life cycle and type of reproduction.

The classification of the Carabidae was taken from LAWRENCE & NEWTON (1995), and ARNETT JR. & THOMAS (2000). The works of ARNETT JR. & THOMAS (2000), DOWNIE & ARNETT JR. (1996), NOONAN (1991), LIEBHERR (1986) and ERWIN (1974) were used as identification key for the majority of species. The Microscope MBS-9 (LOMO) was used for identification of species and separation by sex.

Adults and immature stages of beetles are deposited at the Division Natural Resources GNRA, New York, and at the Jamaica Bay Institute, GNRA, New York.

RESULTS AND DISCUSSIONS

Species Abundance and Diversity. Insect populations of the carabids were collected in V, VII and X months of year 2008. In both sites 230 individuals of 34 species were caught. They belong to 16 genera, 12 tribes, and 6 subfamilies (Table 1). The carabids of both sites differed significantly in the abundance and species richness. The total number of beetles caught in the wet meadow comprised 210 individuals, but the number of species is 27. In the shrub thickets the total number of captured beetles comprised only 20 individuals and 11 species. All beetles collected in the spring in both sides comprised 106 individuals, 94 in the summer, and 30 in the autumn, while 27 species were recorded in the spring, 20 in the summer and 12 in the autumn, respectively. The species of the subfamily Harpalinae were the most abundant, with a total of 20 species: this subfamily contributed to 77.39% of all caught individuals. The species occurring in both sites were *Stenolophus infuscatus* (DEJEAN, 1829), *Paratachys pumilus* (DEJEAN, 1831) and *Scarites subterraneus* (FABRICIUS, 1775). *Chlaenius sericeus* was by far the most abundant species, making up 17.39% of the individuals total. *Stenolophus infuscatus* was the next most abundant species overall, with 10.43% of the total individuals. *Chlaenius impunctifrons* SAY, 1823 made up 10.00% of all carabids trapped. The following eight species *Agonum ferreum* (HALDEMAN, 1843), *Agonum melanarium* (DEJEAN 1828), *Omophron labiatus* (FABRICIUS 1801), *Pterostichus caudicalis* (SAY, 1823), *Calathus opaculus* LECONTE, 1854, *Agonum decorum* SAY, 1823, *Poecilus lucublandus* (SAY, 1823), and *Paratachys pumilus* made a total of 3-8% of the total catch; 6 species *Scarites subterraneus*, *Oodes americanus* DEJEAN, 1826, *Oodes amaroides* DEJEAN, 1831, *Dyschirius aeneolus* LECONTE, 1850, *Omophron nitidum* LECONTE, 1848, *Omophron tessellatus* SAY, 1823, represented 1-2%; other 17 trapped species represented less than 1% each.

Of the total carabids found in the JBWR, three species have been introduced to North America from Palaearctis. *Carabus nemoralis* O. F. MULLER species was found in the site 1 in summer and autumn, whereas *Pterostichus melanarius* (ILLIGER, 1798) and *Harpalus rubripes* (DUFTSCHMID, 1812) was found in the site 2 in autumn and in spring, respectively. These species constituted 8.8% of the total number of species collected in the investigation period. The most abundant species in the site 1 were *Chlaenius sericeus* (19.04%), *Chlaenius impunctifrons* (10.95%), *Stenolophus infuscatus* (10.00%), *Agonum ferreum* (9.52%), *Agonum melanarium* (8.57%) and *Omophron labiatum* (8.57%).

In the site 2 *Calathus opaculus* was the most abundant species and comprised 35.00% of total number of carabids caught in this site. *Agonum ferreum* was captured only in spring in 70% of traps, *Paratachys pumilus* was found in 50% of traps, whereas *Agonum melanarium*, *Stenolophus infuscatus* and *Oodes americanus* were collected in 40% of traps.

In the site 1 the average number (mean ± SE) of individuals per trap collected were 4.8 ± 1.23 in the spring, 5.3 ± 1.62 in summer and 2.1 ± 0.45 in autumn carabids per week, whereas in the site 2 in spring 1.5 ± 0.37, in summer 1.3 ± 0.28 and in autumn 3.0 ± 1.94 per week. In both sites the average catches of specimens per 10 traps per day also varied: in site 1 the average catches constitute in spring 14.3 specimens per10 trap per d., in summer – 13.0, in autumn – 2.7, whereas the average catches in the second site is also lower than in the first site, and constituted in the spring 1.3 specimens per 10 trap per d., in the summer 0.4, and in the autumn 1.7.

In the wet meadow the occurrence of the species ***Chlaenius sericeus, C. impunctifrons, Stenolophus infuscatus*** culminated in summer, representing the highly dominant species. This culmination is reflected by higher values of the Simpson index (index of dominance concentration) or, correspondingly, by a decline of Shannon's index. In spring and autumn, the representation of species ***Agonum ferreum, Chlaenium sericeus, Agonum melanarium, Omophron labiatum*** was more balanced in the reproduction period when the beetles were more active for mating, food and egg laying.

On the contrary, in the shrub thicket the species *Calathus opaculus, Stenolophus infuscatus* become dominant in summer and autumn. It was reflected by the increase of the Simpson's index in both seasons and decline of the Shannon's index and equitability.

Table 1. Survey of species, number of individuals and dominance of carabid in wet meadow and shrub thicketsbetween May and October 2008.
Tabel 1. Lista speciilor, numărul indivizilor şi dominanţa carabidelor în rezervaţia Jamaica Bay Wildlife Refuge în mai-octombrie 2008.

Species	Wet meadow		Shrub thickets	
	N	% Total	N	% Total
Chlaenius sericeus (FORSTER, 1771)	40	19.04	-	-
Stenolophus infuscatus (DEJEAN, 1829)	21	10.00	3	15.00
Chlaenius impunctifrons SAY, 1823	23	10.95	-	-
Agonum ferreum (HALDEMAN, 1843)	20	9.52	-	-
Agonum melanarium DEJEAN, 1828	18	8.57	-	-
Omophron labiatum (FABRICIUS, 1801)	18	8.57	-	-
Pterostichus caudicalis (SAY, 1823)	10	4.76	-	-
Calathus opaculus LECONTE, 1854	-	-	7	35.00
Agonum decorum (SAY, 1823)	9	4.28	-	-
Poecilus lucublandus (SAY, 1823)	8	3.80	-	-
Paratachys pumilus (DEJEAN, 1831)	7	3.33	1	5.00
Scarites subterraneus FABRICIUS, 1775	2	0.95	2	10.00
Oodes americanus DEJEAN, 1826	4	1.90	-	-
Dyschirius aeneolus LECONTE, 1850	4	1.90	-	-
Omophron nitidum LECONTE, 1848	3	1.42	-	-
Omophron tessellatum SAY, 1823	3	1.42	-	-
Oodes amaroides DEJEAN, 1831	3	1.42	-	-
Carabus nemoralis O.F. MÜLLER*	2	0.95	-	-
Nebria lacustris CASEY, 1913	2	0.95	-	-
Calathus gregarius (SAY, 1823)	1	0.47	1	5.00
Clivina striatopunctata DEJEAN, 1831	-	-	1	5.00
Clivina rufa LECONTE, 1857	2	0.95	-	-
Clivina americana DEJEAN, 1831	2	0.95	-	-
Agonum palustre GOULET ,1969	2	0.95	-	-
Amara crassispina LECONTE, 1855	-		1	5.00
Chlaenius emarginatus SAY 1823	2	0.95	-	-
Chlaenius lithophilus SAY, 1823	-	-	1	5.00
Agonum lutulentum (LECONTE, 1854)	-	-	1	5.00
Harpalus rubripes (DUFTSCHMID, 1812)*	-	-	1	5.00
Dyschirius globulosus (SAY, 1823)	1	0.47	-	-
Paratachys proximus (SAY, 1823)	1			5.00
Pterostichus melanarius (ILLIGER, 1798)*	-		1	
Badister transversus CASEY, 1920	1	0.47	-	-
Omophron americanum DEJEAN, 1831	1	0.47	-	-
34	210		20	

Legend: * - a species introduced from the Palearctis (LINDROTH, 1966; KRYZHANOVSKIJ, 1983; KRYZHANOVSKIJ et al., 1995; BOUSQUET & LAROCHELLE, 1993)
Legendă: * - specii introduse din Palearctic (LINDROTH, 1966; KRYZHANOVSKIJ, 1983; KRYZHANOVSKIJ et al., 1995; BOUSQUET & LAROCHELLE, 1993

Sex Ratio. In the wet meadow females prevailed (59.1%), while in the shrub thickets the males were more abundant (55.0%) (Table 3). The male / females ration varied at different seasons. In spring females predominated

(60.6%), the males representing 39.4% of the catch, in summer females represented 57.3% and males 42.7%, in contrast in autumn males moderately predominated 52.0% over the females 48.0%.

Table 2. Diversity indices and equitability of carabids in both sites during the sampling period (2008).
Tabel 2. Indicii diversității și echitabilitatea carabidelor din ambele habitate în perioada de colectare (2008).

Habitat	Spring	Summer	Autumn
Wet meadow	D = 0.332 ± 0.004 H′ = 3.655 ± 0.193 E = 1.145	D = 0.441 ± 0.007 H′ = 3.246 ± 0.192 E = 1.055	D = 0.328 ± 0.003 H′ = 2.944 ± 0.438 E = 0. 855
Shrub thickets	D = 0.368 ± 0.013 H′ = 2.416 ± 0.494) E = 1.660	D = 0.664 ± 0.016 H′ = 1.520 ± 0.498 E = 1.320	D = 1.457 ± 0.073 H′ = 1.417 ± 0.335 E = 0.401

Legend: D – Simpson's index; H′ – Shannon's index; E – equitability.
Legendă: D – indicele lui Simpson; H′ – indicele lui Shannon; E – echiitabilitate.

More females than males were captured in the site 1 in spring (66.4%) and summer (57.1%), while in autumn the count of females was lower than the males (47.4%). In the site 2 there were more males (66.6%) than females (33.4%) whereas in summer there were more females (60.0%) than males (40.0%), but in autumn there was captured the same count of females and males. The sex ratio of carabids in spring, summer and autumn in both sites is given in Table 4. In both sites the average catches also varied per trap per week. In the site 1, in spring 3.9 ± 0.92 females and 2.6 ± 0.65 males were found per trap per week, in summer 3.2 ± 0.84 females and 3.9 ± 1.11 males, and in autumn 1.28 ± 0.19 females and 1.60 ± 0.54 males. In the site 2 in spring 1.1 ± 0.18 males were collected per trap per week, whereas in summer and autumn the number of males decreased; on the contrary, the number of females in spring and summer were lower, but in autumn 1.5 ± 0.70 females were collected per trap per week.

Table 3. The total catch and sex ratio (in %) of carabids in both habitats in 2008.
Tabel 3. Sex ratio (în %) și numărul total de carabide capturate în 2008.

Habitat	∑ (Captured individuals)	♂♂	♀♀
Wet meadow	210	40.9	59.1
Shrub thickets	20	55.0	45.0

The female / male ratio in the most abundant species *Chlaenius sericeus*, *Stenolophus infuscatus*, *Chlaenius impunctifrons*, *Agonum ferreum, Agonum melanarium*, and *Omophron labiatus* was 1.35:1, 0.90:1, 0.91:1, 1.31:1, 2.00:1, and 2.40:1, respectively. Thus, for the following four species *Chlaenius sericeus*, *Agonum ferreum, Agonum melanarium* and *Omophron labiatum* the percentage of females was significantly predominant, while the males predominated in *Stenolophus infuscatus* and *Chlaenius impunctifrons*.

Table 4. The sex ratio (in %) of carabids in both habitats during the growing season of 2008.
Tabel 4. Sex ratio (în %) al carabidelor capturate din ambele habitate în perioada de vegetație (2008).

Growing season	Wet meadow		shrub thickets	
	♂♂	♀♀	♂♂	♀♀
Spring	33.6	66.4	66.6	33.4
Summer	42.9	57.1	40.0	60.0
Autumn	52.6	47.4	50.0	50.0

Seasonal changes in activity of Carabids. The analysis of dynamics of carabids in the study sites has shown that the carabids activity was seasonal. In the site 1 the variations in the activity of adults in spring and summer were very similar. In the spring spring-summer breeders (*Agonum ferreum, Chlaenius sericeus, A. melanarium* and *Omophron labiatum)* predominated, comprised 60.0% of all individuals, while in summer, the species *Chlaenius sericeus, Chlaenius impunctifrons, Stenolophus infuscatus,* comprised 59% predominated. Three species *Chlaenius sericeus*, *Chlaenius impunctifrons* and *Omophron labiatum* were active in this site throughout the growing season. *Chlaenius sericeus* was captured in 70% of traps in spring, in 80% in the summer, and in 20% of traps in autumn; the second wide-spread species *Chlaenius impunctifrons,* occurred in spring in 10%, in summer in 70% and in autumn in 40% of traps; the third species *Omophron labiatus* in the spring was captured in 20% of traps, in the summer in 10%, and in autumn in 30% of traps. Six species, *Omophron nitidum, Clivina americana, Scarites subterraneus, Agonum decorum, Pterostichus caudicalis* and *Pterostichus lucublandus* were active in spring and summer; three species, *Omophron tessellatus, Carabus nemoralis,* and *Stenolophus infuscatus* were active in spring and autumn or in summer and autumn; 13 species, *Nebria lacustris, Clivina rufa, Dyschirius globulosus, Dyschirius aeneolus, Paratachys pumilus, Badister transversus, Chlaenius emarginatus, Chlaenius lithophilus, Oodes americanus, Oodes amaroides, Agonum ferreum, Agonum palustre, Agonum melanarium* were active either in spring, in summer or in autumn. The activity of adults in the site 2 peaked in autumn due a high dominance of *Calathus opaculus,* comprising more 35.0% of

all individuals. This species was active in spring and autumn. *Scarites subterraneus* and *Stenolophus infuscatus* were active in spring and summer. *Scarites subterraneus* was found in 10% of traps in both seasons, whereas *Stenolophus infuscatus* occurred in both season in 20% of traps.

Altogether 34 carabid species belonging to 16 genera were recorded, but this number is lower than the actual number of carabids species in the study area. The majority of the collected species are native and widely distributed in North America. There are significant differences in abundance, species richness and diversity indices of Carabids communities between both sites. The site 1 was located near water and had permanently moist soil. Thus it offers more suitable conditions for hydrophilous carabids like. *Chlaenius sericeus*, *Stenolophus infuscatus*, *Chlaenius impunctifrons, Agonum ferreum*, *Agonum melanarium*, *Omophron labiatus*, *Pterostichus caudicalis* best characterized the site 1 (Table 1). Other less common species of the genera *Agonum* BONELLI, 1810; *Poecilus* BONELLI, 1810; *Paratachys* CASEY, 1918; *Oodes* BONELLI, 1810; *Dyschirius* BONELLI, 1810 and *Omophron* LATREILLE, 1802 were restricted in this site (4-9 specimens). They occurred in spring and summer and they may be also taken as characteristic species for this site. The higher values of Shannon's index in all growing seasons in this site could be related also to the suitable hydrologic conditions and simultaneous occurrence of several hydrophilous species. The value of this index decreased here from spring to autumn (Table 2). Laboratory rearing and field observations of most recorded carabids species (Neculiseanu, unpublished data) showed than to be spring-summer breeders, overwintering as adults, starting to be active in early April. In early May the males were more active than females, in looking for mating. Copulation of some species was observed in May at different time of the night and sometimes also by day on the ground surface. Our survey (Neculiseanu, unpublished data) showed that the first copulations of *Chlaenius sericeus*, *Agonum decorum, Poecilus lucublandus*, *Pterostichus caudicalis*, and *Scarites subteraneus* species occurred on September 05.09.08, 05.11.08, 05.07.08, 05.12.08, and 05.10.08, respectively. After first mating females became very active for food and egg laying. So, at the end of May, when pitfall traps were installed in site 1, more females than males were collected (63♀♀ and 37 ♂♂). The females continue to be active during the entire reproductive period until early August. Thus, in the summer, when the traps were installed (the end of July) also more females than males (52 ♀♀ and 39 ♂♂) were collected. After this period, the activity of females decreased until autumn. So in autumn sample (traps installed in the first half of October), approximately the number of females and males was almost equal (9 ♀♀ and 10 ♂♂). Thus, we observed asynchronous seasonal activity of males and females; in spring and summer the females predominated in wet meadow, but in the autumn, after the reproduction period, both sexes occurred in the equal proportion. The site 2 (dry habitat) dramatically differed from the first habitat and the number of individuals, species, and the average number of catches of individuals per trap per week and per 10 traps per day was lower than site 1 during the research period. The low humidity in this habitat caused these beetles to become less active and, probably, to enter into aestivation.

The lower values of Shannon index in all vegetative season in the site 2 could be also related with very harsh climatic conditions. The decrease of diversity indexes of this site was observed in the same order as in the site 1: spring → summer → autumn (Table 2). This site attracted more the summer-autumn breeders. *Calathus opaculus*, *C. gregarina*, *Harpalus rubripes* and other species belonging to *Clivina, Amara, Paratachys* are species well adopted to dry conditions, that is why they were captured in the sampling period. It is most likely that other factors also affected the carabid populations in their habitats. The adults and larvae of most species of *Agonum* (BONELLI, 1810; *Carabus* LINNAEUS, 1758; *Chlaenius* BONELLI, 1810; *Calathus* BONELLI, 1810; *Omophron* LATREILLE, 1802; *Clivina* LATREILLE, 1802; *Nebria* LATREILLE, 1806; *Pterostichus* BONELLI, 1810; *Poecilus*; *Scarites* FABRICIUS, 1775; *Stenolophus* DEJEAN, 1821; *Paratachys* consume different type of food, but prefer arthropods, especially insects and their immature stages. These species, which comprise more than 90% of all captured carabids have the potential to be important predators in their habitats.

Invasive carabids in research habitats. Occurrence of three non-native carabid species, *Carabus nemoralis, Pterostichus melanarius* and *Harpalus rubripes* introduced from the Palaearctis were recorded in our study. These species constituted 8.8% of the total number of species recorded by us. No of them exceeded 1% of the total caught individuals. *Carabus nemoralis* occurred in the site 1 in summer and autumn. This species is a monovoltine, summer-autumn breeder, overwinters as larva and adult (HŬRKA, 1973), prefer the mixed broad-leaved forests (GEORGII, 1986; NECULISEANU & MATALIN, 2000; NECULISEANU, 2003a), but sometimes occur in the urban habitats, with abundant tree vegetation (KRYZHANOVSKIJ, 1983). Some authors showed that *Carabus nemoralis* is abundantly found in both open and closed habitats (HŬRKA, 1973; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). This Eurosiberian species distributed in Europe (West, Central, Eastern), in the Urals (Southern), easterly of the Urals it is known in West Siberia (Southern) and Tian-Shan (northern) (KRYZHANOVSKIJ, 1983; KRYZHANOVSKIJ et al. 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). In North America this species has been found in city gardens and open woods (DOWNIE & ARNETT, 1996), and is distributed in 13 states of USA (DOWNIE & ARNETT, 1996) and in 33 geographical entities of Mexico (BOUSQUET & LAROCHELLE, 1993). The other introduced species *Pterostichus melanarius* was caught in the site 2 in autumn. This eurytopic species overwinters as larva, seldom as adult (LINDROTH, 1992; HŬRKA, 1975; TOMLIN, 1975; BOUSQUET, 1999; NECULISEANU, 2003a). Some authors consider it to prefer open habitats and to be well adapted to arable land (KRYZHANOVSKIJ, 1983; SHELTON et al. 1983; DESENDER & ALDERWEIRELDT, 1988 et al.). Many authors also found this species in forests (GEORGII, 1986; VARVARA & ZUGRAVU, 2004) and gardens (GOULET et al., 2004; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). Other authors showed that this species is caught either from agricultural habitats or from forests (MEDVEDEV & SHAPIRO, 1957; NECULISEANU, 1991; 2003b; NECULISEANU &

MATALIN, 2000). *Pterostichus melanarius* (eurosiberian species) is distributed in Europe, Caucasus region (Major, Minor, Central), the Eastern part of the Urals namely West Siberia (Northern, Middle, Southern), over the Plains of Kazakhstan, Altais-Sayan Mt. Land and Middle Siberia (KRYZHANOVSKIJ, 1965; 1983; FREUDE et al., 1976; KRYZHANOVSKIJ et al., 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). Its introduction was first recorded in North America in 1926 in Nova Scotia (LINDROTH, 1966). Now it is known in 13 states of USA (DOWNIE & ARNETT, 1996), in America North of Mexico is distributed in 26 geographical entities. *Pterostichus melanarius* has a wider distribution in North America, especially in the northern states and Canada. (BOUSQUET & LAROCHELLE, 1993). Non-native *Harpalus rubripes* was also collected in the site 2, mostly in spring. It is a mixophagous summer-autumn breeder, overwintering as larva and adult (BRIGGS, 1965; NECULISEANU, 2003). Some authors (KRYZHANOVSKIJ, 1965; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005; LER, 1989) consider it to prefer open habitats and other authors found it also in the forest glade. This species has Palearctic distribution, reaching from Europe, Anatolia, Caucasus, Siberia, Kazahstan, Central Asian Mountains, China (Ganshu) to the South of Primorie and the North Sakhalin (LER, 1989; KRYZHANOVSKIJ et al., 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). *Harpalus rubripes* has a more restricted distribution in the North America than other two introduced species. It was first recorded in North America in New Hampshire by BELL & DAVIDSON (1987), and in Connecticut by KRINSKY & OLIVER (1988). BOUSQUET & LAROCHELLE (1993) showed that this species occurs in America, North of Mexico in Connecticut, New Hampshire and Rhode Island. Our data confirm its distribution also in New York.

CONCLUSIONS

1. In both sites 34 carabid species (230 individuals) belonging to 16 genera, 14 tribes, and 6 subfamilies were recorded from May to October 2008. Autochthonous species represented 91.2% of all species. *Carabus nemoralis, Pterostichus melanarius* and *Harpalus rubripes,* introduced from Palaearctis, constituted 8.8% of all species. Harpalinae was the most abundant and richest in species subfamily, comprising 77.39% of all species. The majority of ground beetles species recorded in the site 1were spring-summer breeders, overwintering as adults, but the species from the site 2 with summer-autumn breeders, overwintering as larvae.

2. Activity of Carabids in the site 1 was greater in spring and summer, and declined in autumn. At that time the activity of spring-summer breeders *Chlaenius sericeus, Stenolophus infuscatus, Chlaenius impunctifrons, Agonum ferreum, Agonum melanarium* and *Omophron labiatum* culminated. They comprised about 60.0% of all individuals captured specimens. In the site 2 a greater activity was in spring and autumn, with activity declining in summer. This peak of activity of adults was due to a high dominance species *Calathus opaculus,* which comprised more 40.0% of all individuals.

3. There are significant differences in diversity of carabids in both study lots. The higher values of Shannon's index in all vegetative seasons could be related to good climatic conditions in the site 1 and value of this index decreased here from spring to autumn (3.655, 3.246, 2.944). This index had lower values in all vegetative seasons in the site 2 with harsh climatic conditions but the value of this diversity index also decreases in the same order as in the site 1 from spring to autumn (2.416, 1.520, 1.417). The Simpson's index in the site 1 had the highest value in summer (0.441), but in the shrub thickets this index had the highest value in autumn (1.457).

ACKNOWLEDGEMENTS

I am grateful to George Frame, Biologist at the Division Natural Resources GNRA, New York, Kim Tripp, Director/Research Coordinator Jamaica Bay Institute, GNRA, New York, and all Jamaica Bay Wildlife Refuge staff for the support in conducting the entomological studies in this Refuge. I also thank my son Zaharia Jr. and my daughter Elvira for their help in organization of field's research and collecting materials, for statistical consultation and reviewing the manuscript. This study was carried out as a part of the scientific project "Ground-Beetles (Coleoptera, Carabidae) of the Jamaica Bay Wildlife Refuge", New York (GATE-00189, NPS, Gateway NRA).

REFERENCES

ARNETT R. H. JR. & THOMAS M. C. 2000. *American Beetles. Archostemata, Myxophaga, Adephaga, Polyphaga: Staphiliniformia.* CRC Press LLC. **1**: 33-132.

BELL R. T. & DAVIDSON R. L. 1987. *Harpalus rubripes Duftschmid, a European ground beetle new for North America (Coleoptera: Carabidae).* Coleopterists Bulletin. (Whitehead, D. R., ed.). **41**: 56-57.

BOUSQUET Y. 1999. *Supraspecific classification of the Nearctic Pterostichini (Coleoptera: Carabidae).* The Entomological Society of Canada, Fabreries, Supplement. **9**. 292 pp.

BOUSQUET Y. & LAROCHELLE A. 1993. *Catalogue of the Geadephaga (Coc. Trachypachidae, Rhysodidae, Carabidae, incl. Cicindelini) of America North of Mexico.* Memoirs of the Entomological Society of Canada, V. Behan-Pelletier, Editor. **167**: 43- 397.

BRIGGS J. 1965. *Biology of some ground beetles (Coleoptera: Carabidae) injuriorius to strawberries.* Bulletin of Entomological Research. Published by Cambridge University. **56**: 79-93.

DESENDER K. M. & ALDERWEIRELDT A. 1988. *Population dynamics of carabid beetles and larvae in a maize field and its boundary.* Zeitschrift für Angewandte Entomologie. Wiley Blackwel. **106**: 13-19.

DOWNIE N. M. & ARNETT R. H. JR. 1996. *The Beetles of Northeastern North America. Introduction, Suborder Archostemata, Adephaga, and Polyphaga, thru Superfamily Cantharoidea.* The Sandhill Crane Press. Publisher Gainesville, Florida. **1**: 87-218.

ERWIN T. L. 1974. *Studies of the Subtribe Tachyina (Coleoptera: Carabidae: Bembidiini), Part II:* A Revision of the New World-Australian Genus *Pericompus* Le Conte. Smithsonian Contributions to Zoology. **162**: 1-96.

FREUDE H., HARDE K. W., LOHSE G. A. 1976. *Familie: Carabidae (Laufkäfer),[Chapter]1.* In: Die Käfer Mitteleuropas. Band 2, Adephaga 1. (Freude, H., Harde, K. W. and Lohse, G. A., eds.). Goecke und Evers, Krefeld: 7-302.

GEORGII H. W. 1986. *Atmosferic pollutants in forest areas: Their deposition and interception.* Edited by Georgii H. W. 287 pp.

GOULET H., LESAGE L., BOSTANIAN, N. J., VINCENT C., LASNIER J. 2004. *Diversity and Seasonal Activity of Ground Beetles (Col. Carabidae) in two Vineyards of Southern Quebec (Canada).* Annals of the Entomological Society of America. Published by Entomological Society of America. **97**: 1263-1272.

HŮRKA K. 1973. *Fortpflanzung und Entwicklung der mitteleuropäischen Carabus and Procerus* .Arten. Studie ČSAV. **9**: 1-78

HŮRKA K. 1975. *Laboratory studies on the life cycle of Pterostichus melanarius (Illiger) (Coleoptera, Carabidae).* Věstník Československé společnosti zoologické. **39**(4): 265-274.

INGRAHAM J., RIEPE D., TUDOR G. 1989. *Butterflies of the Jamaica Bay.* Pamphlet for Gateway National Recreation Area, National Park Service, NY. 13 pp.

KRINSKY W. L. & OLIVER M. K. 1988. *Carabids previously unreported from Connecticut (Coleoptera:Carabidae).* The Coleopterists Bulletin. Published by Coleopterists Society. 42: 387-396.

KRYZHANOVSCKIJ O. L. 1983. *: Families Rhysodidae, Trachypachidae, Carabidae.* Fauna SSSR, Zhestkokrylye. Zhuki podotriada Adephaga Nauka, Leningrad. **1**(2). 341 pp.

KRYZHANOVSKIJ O. L., BELOUSOV I. A., KABAK I. I., KATAEV B. M., MAKAROV K.V., SHILENKOV V.G. 1995. *A Checklist of the Ground-Beetles of Russia and Adjacent Lands (Insecta, Coleoptera, Carabidae).* Pensoft Sofia-Moscow. 271 pp.

LAWRENCE J. F. & NEWTON A. F. JR. 1995. *Families and subfamilies of Coleoptera (with selected genera, notes, references and data on family-group names).* In: Biology, phylogeny, and classification of Coleoptera: Papers celebrating the 80th birthday of Roy A Crowson (Pakaluk, J., and S. A. Ślipinski eds). Museum i Institut Zoologii PAN. Warszawa: 779-1006.

LER P. A. 1989. *Opredeliteli nasekomykh Dal'nego Vostoka SSSR.* Nauka. **3**. 704 pp.

LIEBHERR J. K. 1986. Cladistic *Analysis of North American Platynini and Revision of the Agonum extensicolle Species Group (Coleoptera:Carabidae).* Entomology. University of California Publications. **106**. 197 pp.

LINDROTH C. H. 1966. *The ground beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska.* Opuscula Entomologica Published by Entomological Society in Lund, Sweden (Scandinavian Entomology). Part 4 Supplementum. 29: 409-648.

LINDROTH C. H. 1992. *Ground beetles (Carabidae) of Fennoscandi.,* A Zoogeographic Study, Part **I-III**, Specific Knowledge Regarding the Species. Smithsonian Institution Libraries, Washington, D.C. 806 pp.

MEDVEDEV S. I. & SHAPIRO D. S. 1957. *To the study of the coleopteran fauna of SSR Moldavia and adjacent districts of the Ulraine.* Uchenye zapiski Kharkovskogo Universiteta. **27**: 173-189.

NECULISEANU Z. Z. 1991. *A review of the ground beetles (Coleoptera: Carabidae) of Moldova.* Izvestiya Akademii nauk Moldavskoi SSR, seria Biologicheskikh i Khimicheskikh nauk. Ştiinţa. Chişinău. **2**: 37-42

NECULISEANU Z. Z. 2003a. *Ground Beetles (Coleoptera: Carabidae) of the zone of biogeographical interference (taxonomy, zoogeography, diversity, biology) and their practical significance.* Dr. habilitated thesis, Institute of Zoology ASM. Kishinev. Moldova. 40 pp.

NECULISEANU Z. Z. 2003b. *Live cycles and reproduction of ground beetles (Coleoptera: Carabidae) of the Republic of Moldova.* Buletin Informativ. Societatea Lepidopterologică Română. Cluj-Napoca. **14**(1-4): 5-14.

NECULISEANU Z. Z. & MATALIN A. M. 2000. *A Catalogue of the Ground Beetles of the Republic of Moldova (Coleoptera: Carabidae).* Pensoft, Sofia-Moscow. 164 pp.

NOONAN G. R. 1991. *Classification, Cladistics, and Natural History of Native North American Harpalus Latr. (Insecta: Coleoptera: Carabidae: Harpalini), Excluding Subgenera Glanodes and Pseudophonus.* The Thomas Say Foundation. **13**. 310 pp.

SHELTON A. M., ANDALORO J. T., HOY C. W. 1983. *Survey of ground-dwelling predaceous and parasitic arthropods in cabbage fields in upstate New York.* Environmental Entomology. Published by the Entomological Society of America **12**: 1026-1030.

TOMLIN A. D. 1975. *Notes on the biology and rearing of two species of ground beetles, Pterostichus melanarius and Harpalus pensylvanicus (Coleoptera: Carabidae).* Canadian Entomologist, Publication of the Entomological Society of Canada. **107**(1): 67-74.

VARVARA M. &. ZUGRAVU F. 2004. *Contributions to the study of Carabids (Coleoptera: Carabidae) from the Gadinti forest, Neamț county.* Analele Ştiinţifice ale Universităţii „Al. I. Cuza", Iaşi, Seria Biologie animală. **50**: 157-172.

ZELAZNA E. & BLAZEJEWICH-ZAMADZINSKA M. 2005. *Species diversity of Carabids (Col., Carabidae) in different types of Bydgoszcz Urban Green Belts and suburban environments.* Folia biologica (Krakow), Supplement. **53**: 179-187.

Neculiseanu Zaharia
1479 Dahill Road, Apt. C5, Brooklyn, NY, New York, 11204
E-mail: zneculiseanu@yahoo.com

Received: March 24, 2011
Accepted: August 29, 2011

DISTRIBUTION AND RELATIVE ABUNDANCE OF THE SPECIES *Poecilus cupreus* LINAEUS 1758 (COLEOPTERA: CARABIDAE) IN SOME WHEAT AND POTATO CROPS FROM ROMANIA, 1977-2002

VARVARA Mircea, ŠUSTEK Zbyšek

Abstract. The paper is a synthesis of huge data on the occurrence of *Poecilus cupreus* L. in some wheat fields from 16 localities, 8 counties (1977-2002) and potato fields from 14 localities, 8 counties (1984-1999) in Romania. The material was pitfall-trapped, installing mostly 12 traps in each locality, a luxuriously sufficient number to characterize the dominance structure of a community. The traps were exposed in the wheat fields for 35 – 138 days (average 79 days) from 10 April to 1 August, while in potato fields they were exposed for 21 – 154 days (average 100 days) from 16 April to 30 September. The abundance and dominance of *Poecilus cupreus* showed a wide variability in the wheat fields: from 2 individuals (0.78% in the locality Brăila, Terasă, 1982, Brăila county) to 3,210 individuals (89.66%, Brăila, Lacul Sărat, 1983). In the potato fields, the abundance and relative abundance ranged from 1 individual (2.44% locality Târgu Jiu, 1994, Gorj county) to 742 (63.58 %, locality Zvoriştea, 1993, Suceava county). In the wheat fields *P. cupreus* was eudominant in 72% of the studied localities, with the dominance ranging from 10.42% in Căbeşti in 1983 (Bacău county) to 89.66% in Lacul Sărat in 1983 (Brăila county). In the potato fields it was eudominant in 42% of localities, where its dominance ranged from 12.04%, Braşov in 1985 (Braşov county) to 63.58%, Zvoriştea in 1993 (Succava county). *Poecilus cupreus* is an Eurosiberian, spring breeding (May, June), mesophilous to moderately hydrophilous, panthophagous species, occurring in arable land and meadows.

Keywords: Romania, wheat and potato crops, Carabidae, *Poecilus cupreus*, communities.

Rezumat. Răspândirea şi abundenţa relativă a speciei *Poecilus cupreus* (LINAEUS 1758) (Coleoptera: Carabidae) în unele culturi de grâu şi cartofi din România, 1977-2002. Lucrarea este o amplă sinteză a colectării indivizilor speciei *Poecilus cupreus* din culturile de grâu din opt judeţe, 16 localităţi (1977-2002) şi culturile de cartofi din opt judeţe, 14 localităţi (1984-1999), din România. Pentru colectarea materialului de carabide epigee, în marea majoritate a localităţilor, au fost folosite câte 12 capcane Barber în fiecare cultură, număr de capcane suficient pentru a se colecta toate grupele de dominanţă ale speciei. Capcanele Barber au funcţionat continuu în culturi, între 35 şi 138 zile, în medie, 79 de zile, de la 10 aprilie până la 1 august, în culturile de grâu şi între 21 şi 154 zile, în medie, 100 de zile, de la 16 aprilie până la 30 septembrie, în culturile de cartofi. Abundenţa şi dominanţa speciei *P. cupreus*, în culturile de grâu, a prezentat o amplă variaţie: doi indivizi (0,78%, Brăila, Terasă, 1982, Judeţul Brăila) şi 3 210 indivizi (89,66%, Brăila, Lacul Sărat, 1983). În culturile de cartofi, dominanţa a variat între un individ (2,44%, Târgu Jiu, 1994 Judeţul Gorj) şi 742 (63.58 %, Zvoriştea, 1993, Judeţul Suceava). În culturile de grâu, *Poecilus cupreus* este eudominant în 72 % din localităţile cercetate (procentele dominanţei variind de la 10,42 % Căbeşti, 1983 (judeţul Bacău) şi până la 89,66%, Lacul Sărat, 1983, (judeţul Brăila). În culturile de cartofi, *Poecilus cupreus* este eudominant în 42 % din localităţile de unde s-a colectat materialul, procentele variind între 12,04%, Braşov, 1985 (judeţul Braşov) şi 63,58%, Zvoriştea, 1993, (judeţul Suceava). *Poecilus cupreus* se reproduce în primăvară, mai, iunie, specia fiind mezofilă până la moderat hidrofilă, răspândită în agroecosisteme, păşuni şi fânete, pantofagă, eurosiberiană.

Cuvinte cheie: România, culturi de grâu şi cartofi, Carabidae, *Poecilus cupreus*, cenoze.

INTRODUCTION

Community structure and especially their population density and dominance (=relative abundance) of Carabids in the agroecosystems (wheat, potatoes, sugar beet, maize, alfalfa, clover, etc.) are influenced by many synergically acting factors, like pedological and hydrological conditions, microclimatic conditions specific for each crops stand, duration and timing of crop presence on the field, agrotechnical measures, and chemical pest control. Knowledge of trends in structural changes of carabid communities in all types of ecosystems is of essential importance for the assessment of their state and for understanding of processes running in the nature in conditions of changing climate characterized first of all by the more frequent incidence of extreme climatic phenomena. The main goals of the present paper are (1) to specify the variation in the relative abundance of *Poecilus cupreus* LINNAEUS, 1758, one of the most abundant carabids in wheat and potato fields in some climatically different regions of Romania, viz Târgu Jiu basin (Oltenia), Braşov (Transylvania, Ţara Bârsei region), Muntenia (Brăila region) and Moldova in dependence on different habitat conditions in regional and local scales and (2) to present some observations on its sex ratio and seasonal dynamics. Similarly as earlier papers (VARVARA 2011 and in press) referring to *Pseudophonus rufipes* (DE GEER 1774) and *Pterostichus melanarius* (ILLIGER 1798) in the wheat and potato fields, this paper synthesizes extensive original quantitative data originating from a long-termed (10-12 years) collecting of beetles in the same crop. Such a collecting was possible only thanks to collaboration at the scientific contracts with the Potato Protection Station of Braşov and due to the opportunity to lead works of licensing for students and theses for obtaining the first degree for the secondary school teaching. Thus, the entire entomological material obtained during these works was collected by the students and identified by the senior author.

The general data on the distribution and autecology of field Carabids were taken from the works by DUSHENKOV (1984); KABACIK-WASILIK (1970); KARPOVA (1984); LINDROTH (1949); PORHAJAŠOVÁ et al. (2008) and TIETZE (2003). The data on the occurrence of Carabids in fields in Romania come from BANIŢĂ et al. (1994); BICA (2005); CHIRECEANU (2009); DONESCU & ENIOU (1995); POPESCU & ZAMFIRESCU (2004); TEODOREANU (1970); VARVARA (2001, 2003, 2005, 2011a, 2001b) and VARVARA et al. (1990, 1993, 1999, 2003).

MATERIAL AND METHODS

In the period 1977-2002, an extensive material of Carabids was collected in potato and wheat fields in Transylvania (counties Braşov and Covasna), Moldavia (counties: Bacău, Iaşi, Neamţ, Botoşani, and Suceava), Muntenia (Argeş County), Oltenia (Dolj and Gorj Counties), Dobroudja (Tulcea County) and wheat fields in Muntenia (Brăila County) and Moldavia (counties: Galaţi, Vrancea, Bacău, Vaslui, Iaşi, Suceava, Botoşani). In most sites 12 pitfalls were installed. This number proved to be sufficient to record reliably about 80% of occurring species and to exactly characterize quantitative proportion in of all dominant species (OBRTEL, 1971).

The basin of Ţara Bârsei region has an area of 2,406 km^2. Its altitude varies between 504 m (Feldioara area) and 723 m (Braşov area). Due to its geographical position within Romania, the climate of Ţara Bârsei region is temperate continental, mesophilous, with annual average temperature of 7.8°C; the annual average rainfall varies between 548-782 mm, reaching a maximum in Braşov area. In this region, summers are cool because of the mountain influence. The warmest months are July and August, when the temperature rises to 25°C.

Târgu Jiu basin comprises floodplain meadows and river terraces. 80% of the basin's area has a temperate continental climate. The annual average air temperature is 10.2°C at Târgu Jiu. Annual average rainfall is 753.0 mm. In Târgu Jiu basin, the brown alluvial soils predominate on the extensive Jiu river floodplain. The cereals, potatoes and vegetables occupy large surfaces in the centre and south of the county. The average yields are below the Romanian average.

Moldavia is a zoogeographical district (KIS, 1970) characterized by a continental climate, with the annual average temperature between 7.0 and 9.0°C, annual average precipitations of 450-650 mm. The climate of Moldavia is temperate continental. Correlatively with the rising of the altitude, two zones are evident here. The cooler western zone of Moldavia with an annual average temperature of 8.5°C and precipitations of 600-700 mm, and the eastern zone with the annual average temperature of 9.5°C and precipitations of 450-550 mm. Within the western zone three climatic districts are distinguished: (1) the northern one with the southern limit southerly of Iaşi city (annual precipitation 500-600 mm, average annual temperature 9.4°C); (2) the central one with the southern limit southerly of Huşi town (annual precipitation 400-500 mm, average annual temperature 9.5°C) and (3) the southern one (annual precipitation 400-500 mm, average annual temperature 10.5°C). (according to www.meteoromania.ro).

The collecting effort is generally characterized in Table 1 and in details in Tables 2 and 3 (localities, period of the pitfalls exposition, length of their operation, total number of pitfalls used, total number of catches and samples examined, locality and year. To describe the occurrence of *Poecilus cupreus* in the wheat and potato fields, the variation of its dominance, dynamics and sex ratio are given. The material was collected at Braşov for 12 years (1984-1998), near Târgu Jiu for 10 years (1987-1998), in Mârşani for three years (1987-1989), in Muntenia, Brăila County, for five years (1981-1985) and in Moldova for 10 years (1978-2002).

For simplicity, the absolute number of individuals is called as "abundance" and the relative abundance as "dominance".

Table 1. General characteristic of the collecting of Carabids in wheat and potato fields 1977-2002. / Tabel 1. Caracteristica generală a efortului de colectarea carabidelor în culturile de grâu şi cartofi, 1977-2002.

Parameter	Wheat	Potato
Period of sampling	1977 – 2002	1984 - 1999
Years of sampling	14	15
Total number of pitfalls used	329	430
Average of pitfalls per site	12	11
Range of number of pitfalls used	6 – 35	5 - 17
Total number of effective days of pitfalls exposition	2098	3994
Average length of pitfalls exposition per site	81	105
Range of pitfalls exposition per site	35 – 138	21 - 154
Total number of analysed samples	2218	8542
Average per locality	85	224
Range of number of analysed samples	24 – 210	24 - 520

RESULTS

Numerical and percentage variations of abundance and dominance of *Poecilus cupreus* in wheat and potato fields are given in Table 4.

Poecilus cupreus was collected in 26 wheat fields in eight counties, in alphabetical order: Bacău, Botoşani, Brăila, Galaţi, Iaşi, Suceava, Vaslui, and Vrancea and 38 potato fields (1984-1999), in 11 counties: Argeş, Bacău, Botoşani, Braşov, Covasna, Dolj, Gorj, Iaşi, Neamţ, Suceava, and Tulcea. During 14 years (1977 – 2002) 329 pitfalls functioned (average 12, range 6-35, 2,098 days in total, average 81, range 35-138) here. Altogether 177 catches were obtained from them and 2,218 samples were analysed, on average 85, with a range 24 - 210 (Tables 1 and 2).

During 15 years (1978 –1999), in potato fields, 430 pitfalls functioned (average 11, range 5-17) 3,994 days in total, average 105 per field, range 21-154. A total of 741 catches were effectuated (average 19, range 2-32, and 8,542 samples were analysed, on average 224 per field, with a range 24 -520 (Tables 1 and 3).

Table 2. Detailed data (collecting sites, traps exposition, total number of days, number of traps, catches number, total number of samples) on the collecting of *Poecilus cupreus* from different wheat fields, 1977-2002. / Tabel 2. Date detaliate (locuri de colectare; durata de expunere a capcanelor; total zile; număr de capcane; număr de capturi, total probe) asupra colectării speciei *Poecilus cupreus* din diferite culturi de grâu, 1977-2002.

Sites and year	Traps exposition	Days	Traps number	Catches number	Samples total
Brăila, Terasă 1981, (Brăila County)	May 24 – Sept. 3	102	12	6	72
Brăila, Terasă 1982	May 28 – Aug. 30	95	12	9	84
Brăila, Terasă 1983	May 10 – July 20	71	12	7	84
Brăila, Terasă 1984	May 10 – July 11	63	12	6	72
Brăila, Terasă 1985	April 10 – July 10	92	12	7	84
Brăila, Trăian1985	April 29 – July 10	72	12	7	84
Uzlina 1986	June 1 – July 5	35	12	2	24
Brăila, Lacul Sărat 1981	May 25 – July 15	51	12	3	36
Brăila, Lacul Sărat 1982	May 28 – Aug.30	95	12	7	84
Brăila, Lacul Sărat 1983	May 28 – Aug. 30	95	12	7	84
Brăila, Lacul Sărat 1984	May 8 – July 17	70	12	6	72
Corod, 1983 (Galaţi County)	April 25 - July 10	78	12	7	84
Vaslui 1977 (Vaslui County)	May 1 – July 20	81	12	7	84
Perieni 1989	April 24 – July 28	96	12	8	96
Pogoneşti 1983	April 15 – Aug. 30	137	12	12	144
Căbeşti 1983, (Bacău County)	April 25 – June 25	61	12	6	72
Hemeiuşi 1980	May 1 – Aug. 29	121	12	12	144
Letea Veche 1996	May 1 – July15	76	12	6	76
Adjud 1978, (Vrancea County)	April 15 – July 30	106	12	8	96
Leţcani 1981, (Iaşi County)	May 10 – July 17	68	12	7	84
Leţcani 1982	May 10 – July 16	67	12	7	84
Miroslava 1981	April 20 – July 15	86	12	8	96
Chiriţa 1999	May 1 – July 15	76	35	6	210
Zvoriştea 1993, (Succava County)	May 1 – Aug. 1	93	12	9	108
Sârbi 1999 (Botoşani County)	June 1– July 30	60	6	4	24
Santa Mare 2002	May 10 – June 30	51	12	3	36
Total		2,098	329	177	2,218

Table 3. Detailed data (collecting sites, traps exposition, total number of days, number of traps, catches number, total number of samples) on collecting of *Poecilus cupreus* from different potato fields, 1978-1999. / Tabel 3. Date detaliate asupra colectării (locuri de colectare; durata de expunere a capcanelor; total zile; număr de capcane; număr de capturi, total probe) a speciei *Poecilus cupreus* din diferite culturi de cartofi, 1978-1999.

Sites	Traps exposition	Total days	Pitfalls number	Catches number	Samples total
Braşov 1984 (Braşov County)	May 29 – Sept. 12	107	13	20	260
Braşov, 1985	April 16 - Sep. 4	142	13	31	403
Braşov, 1986	May 29 – Sept.12	107	13	30	390
Braşov, 1987	May 29 – Sept. 12	107	13	30	390
Braşov,1988	May 29 – Sept. 12	107	13	29	377
Brasov, 1989	May 29 – Sept. 12	107	8	27	216
Braşov, 1991	June 10 – Aug. 14	66	17	12	204
Braşov, 1992	June 1 – Sept. 15	107	12	20	240
Braşov, 1993	June 1 – Sept. 15	107	12	20	240
Braşov, 1996	June 1 – Sept. 20	112	12	20	240
Braşov,1997	May 24 – June 13	21	12	2	24
Braşov, 1998	June 30 – Sept. 18	80	12	15	180
Târgu Secuiesc, 1987 (Covasna County)	May 15 –Aug. 24	101	7	23	161
Mârşani, 1987 (Dolj County)	May 1 – Aug. 30	122	13	40	520
Mârşani, 1988	April 15 – Aug. 27	137	13	22	286
Mârşani, 1989	April 15 – June 29	66	10	6	78
Târgu Jiu, 1987 (Gorj County)	May 5 – Sept. 13	131	13	21	273
Târgu Jiu,1988	June 1 – Sept. 13	105	13	37	481
Târgu Jiu, 1989	May 10 – Aug. 26	108	13	32	416
Târgu Jiu.1991	July 1 – Aug. 30	61	10	10	100
Târgu Jiu, 1993	May 25 – Aug. 30	97	12	18	216
Târgu Jiu, 1994	May 3 – Aug. 19 .	108	12	18	216
Târgu Jiu, 1995	May 1 – Aug. 16	108	12	32	384
Târgu Jiu, 1996	May 1 – Sept 1	124	12	28	336
Târgu Jiu, 1997	May 25 – July 19	55	12	21	252
Târgu Jiu, 1998	May 1 – Aug. 30	122	12	32	420
Tulcea, 1987 (Tulcea County)	May 12 – Sept. 9	121	5	31	155
Podul Dâmboviţei, 1988 (Arges County)	April 1 – Sept. 30	183	5	24	120
Dofteana, 1978 (Bacău County)	May 1 – Sept. 15	138	12	18	216
Secuieni, 1997 (Bacău County)	May 11 - July 30	81	12	8	96
Vânători, 1999 (Iaşi County)	May 20 – Sept.15	118	12	7	84
Zvoriştea, 1993 (Suceava County)	April 26 – July 25	91	12	8	96
Zvoriştea, 1995	May 15 – Aug. 25	102	12	10	120
Zvoriştea, 1998	May 15 – Sept. 15	123	6	9	54
Dorna Arini, 1993	May 10 – July 30	81	10	7	70
Dragomirna, 1995	May 1 – Aug. 20	112	12	8	96

Vicovu de Jos, 1998	May 15 – Aug. 30	107	12	7	84
Sârbi, 1999 (Botoşani County)	June 1 – Sept. 30	122	6	8	48
Total		3,994	430	741	8,542

Among 25 wheat fields (Table 4) *Poecilus cupreus* was found in 24 localities, where 9,124 individuals of *Poecilus cupreus* were collected, i. e. 365 individuals per locality (380 ind. per the positive locality), with an ample variation of dominance and abundance in the positive catches, ranging from 0.78% (2 individuals, Brăila, at the point called Terasă, Brăila County, 1982) to 89.66% (3,210 individuals, Brăila, Lacul Sărat, 1983). It was eudominant in 20 localities (80%), dominant, subdominant, recedent or subrecedent in one locality. Only in one wheat field, at Vaslui, 1977 (Table 4), it was not found at all.

Among 38 potato fields (Table 4) it was found in 28 fields, where 2,945 individuals was collected, with an average of 77 individuals per locality (105 ind. per positive locality) and a variation of abundance in the positive catches form one individual (Târgu Jiu, 1994 and 1998, Dolj County) to 742 individuals (Zvoriştea, 1993, Suceava County). In these fields its dominance ranged between 0.35%, (Sârbi, 1999) and 63.58% (Zvoriştea, 1993) (Table 4). During 1984-1999 it was eudominant in 17 localities (44.74%, Table 4) and in further five localities dominant (13.15%) in six localities (15.79%) subrecedent to subdominant. Its absence or very low abundance was recorded first of all in the fields near Târgu Jiu (Table 5, Fig. 1). When excluding the localities and years without any individual recorded, the numbers of individuals in potato fields are lower than in wheat, but much more stable (coefficient of variance 142% in potato, but 185% in wheat).

Table 4. Abundance (A) and dominance (D in %) of *Poecilus cupreus* in the wheat and potato fields from individual years and localities of Romania. / Tabel 4. Abundenţa (A) şi dominanţa (D %) speciei *P. cupreus* în culturile de grâu şi cartofi din unele localităţi ale României.

Wheat			Potato		
Locality and year	**A**	**D**	**Locality and year**	**A**	**D**
Brăila, Terasă 1981	125	45.78	Braşov 1984	53	4.36
Brăila, Terasă 1982	2	0.78	Braşov 1985	109	12.04
Brăila, Terasă 1983	235	68.51	Braşov 1986	129	19.79
Brăila, Terasă 1984	60	30.61	Braşov 1987	127	19.66
Brăila, Terasă 1985	101	61.59	Braşov 1988	92	17.59
Uzlina, 1986	82	32.41	Brasov 1989	61	34.27
Brăila, Lacul Sărat 1981	147	54.65	Braşov 1991	112	54.63
Brăila, Lacul Sărat 1982	178	48.77	Braşov 1992	210	60.87
Brăila, Lacul Sărat 1983	3,210	89.66	Braşov 1993	170	30.25
Brăila, Lacul Sărat 1984	29	26.01	Braşov 1996	25	5.59
Corod 1983	94	28.75	Braşov 1997	4	20.00
Vaslui 1977			Braşov 1998	31	28.44
Perieni 1989	99	40.08	Mârşani 1987		
Pogoneşti 1983	7	1.51	Mârşani 1988		
Căbeşti 1983	5	10.42	Mârşani 1989	61	34.27
Hemeiuşi 1980	889	79.23	Târgu Jiu 1987	3	6.98
Letea –Veche 1996	657	37.33	Târgu Jiu 1988	19	21.59
Adjud 1978	61	23.83	Târgu Jiu 1989		
Leţcani 1981	547	52.39	Târgu Jiu 1991		
Leţcani 1982	800	65.36	Târgu Jiu 1993		
Miroslava 1981	188	51.37	Târgu Jiu 1994	1	2.44
Chiriţa (Iaşi) 1999	87	29.49	Târgu Jiu 1995		
Zvoriştea 1993	1,474	78.07	Târgu Jiu 1996	5	6.41
Sârbi 1999	9	2.20	Târgu Jiu 1997		
Santa Mare 2002	38	7.85	Târgu Jiu 1998	1	2.44
			Podul Dâmboviţei 1988		
			Tulcea 1987		
			Târgu Secuiesc 1986	120	29.34
			Dofteana 1978	30	5.21
			Secuieni 1997	201	25.38
			Zvoriştea 1993	742	63.58
			Zvoriştea 1995	108	8.37
			Zvoriştea 1998	156	27.23
			Dorna Arini 1993	1	0.40
			Dragomirna 1995	358	43.77
			Vicovu de Jos 1998	14	2.16
			Vânători 1999		
			Sârbi 1999	2	0.35
Total	9,124			2,945	
Average[1]	364.96	38.67		77.50	15.46
Standard deviation[1]	692.83	26.41		136.89	18.19
Average[2]	380.17	40.28		105.18	20.98
Standard deviation[21]	703.46	25.70		150.53	18.25

Explanations: Average[1] and Standard deviation[1] include all localities
Average[2] and Standard deviation[2] include only localities, where *Poecilus cupreus* occurred

Distribution of dominance of *Poecilus cupreus* within the whole material is shown in Table 6. In altogether 57.90% of one-year catches it was eudominant or dominant, in 26.32% of catches (as matter of fact in those from Târgu Jiu) it was absent in the localities studied, but only in a small portion of localities it had a low dominance, not exceeding 5%.

Table 5. Potato fields. *Poecilus cupreus*, regional variation of the number of collected individuals. / Tabel 5. Culturi de cartofi *Poecilus cupreus*, variaţia regională a numărului de indivizi colectaţi.

Locality	Period	Years	Samples	Individuals	Average %	Range of %
Braşov	1984-1998	12	3,164	1,123	39.75	4.36 – 60.87
Târgu Jiu	1987-1998	10	3,214	90	3.19	0.00 – 21.59
Moldova	1978-1999	10	964	1,612	57.06	0.00 – 63,58
Total			7,342	2,825	100.00	

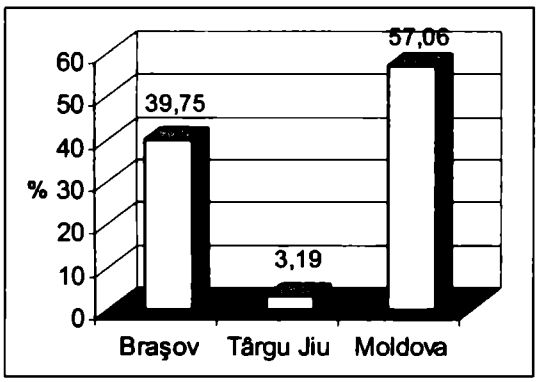
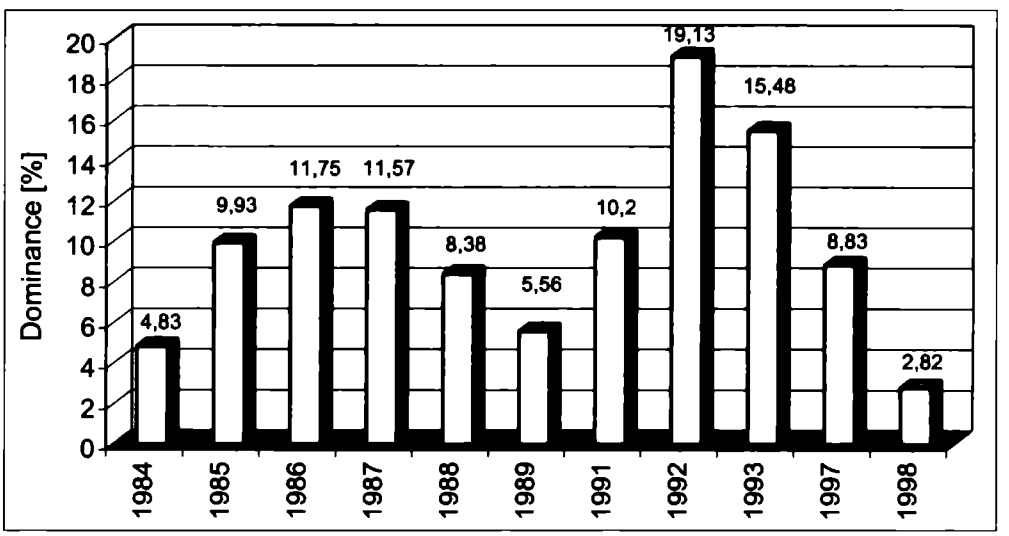


Figure 1. The regional variation of average dominance of *Poecilus cupreus* in potato fields.
Figura 1. Variaţia regională a dominanţei medii de *Poecilus cupreus* colectaţ din cuturile de cartofi.



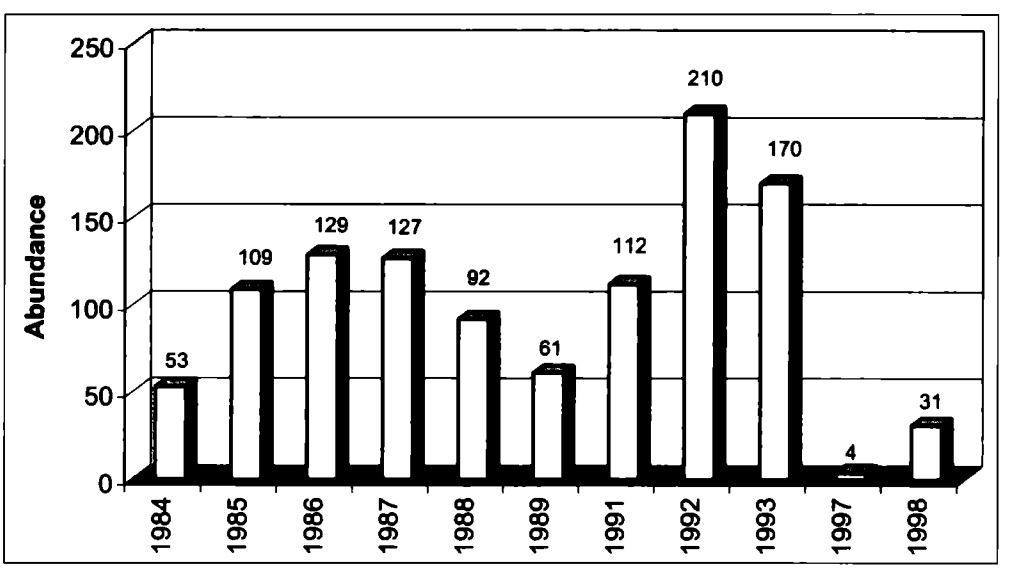


Figure 2a – 2b. Annual variation in abundance and dominance of *Poecilus cupreus* in potato fields near Braşov (Ţara Bârsei region).
Figura 2a – 2b. Variaţia anuală a abundenţei şi dominanţei a speciei *Poecilus cupreus* în culturile de cartofi lângă Braşov (Ţara Bârsei).

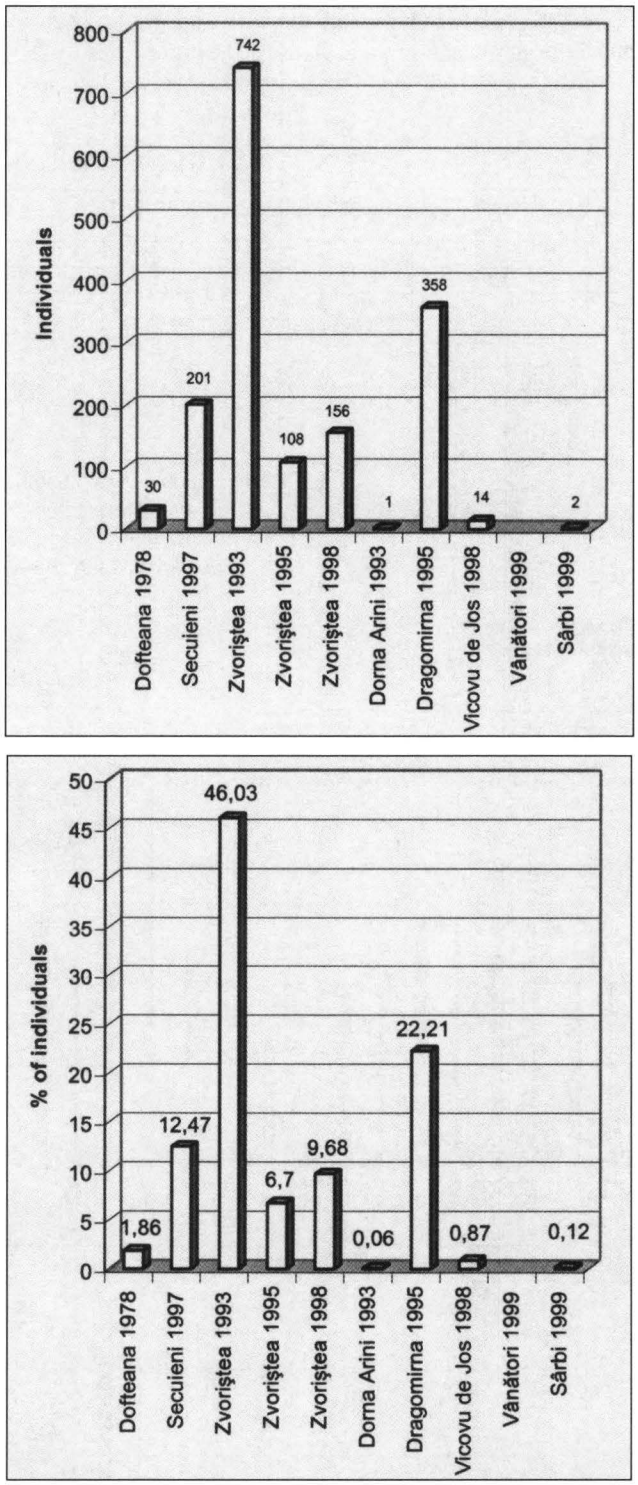


Figure 3a – 3b. Variation of abundance and dominance of *Poecilus cupreus* collected from potato fields of Moldavia.
Figura 3a – 3b. Variația abundenței și dominanței speciei *Poecilus cupreus* din diferite culturi de cartofi ale Moldovei.

Table 6. Variation in dominance of *Poecilus cupreus* in wheat and potato fields. / Tabel 6. Variația dominanței speciei *Poecilus cupreus* în culturile de grâu și cartofi.

Dominance classes	Wheat fields		Potato fields	
	Number	%	Number	%
Absent	1	4.0	10	26.32
Subrecedent < 1%	1	4.0	2	5.26
Recedent 1.1-2%	1	4.0	0	0.00
Subdominant 2.1-5%	1	4.0	4	10.53
Dominant 5.1-10%	1	4.0	5	13.16
Eudominant > 10.1%	20	80.0	17	44.74
Total	25	100.0	38	100.0

Table 7. The monthly changes in sexual ratio of *Poecilus cupreus* and its seasonal dynamics in wheat field at Zvorişţea in 1993 and potato field at Târgu Secuiesc in 1986. / Tabel 7. Raportul lunar numeric şi procentual între masculi şi femele la *Poecilus cupreus* şi dinamica lui sezonieră în cultura de grâu la Zvorişţea în 1993 şi cultura de cartofi, Târgu Secuiesc în 1986.

Localities	Month	Sex ratio				Dynamics	
		Males		Females			
		ind.	%	ind.	%	ind.	%
Zvorişţea	May	289	37.53	481	62.47	770	53.44
	June	141	29.62	335	70.38	476	33.03
	July	63	32.31	132	67.69	195	13.53
Târgu Secuiesc	May	16	22,54	55	77.6	71	59.17
	June	10	25.64	29	74.36	39	32.50
	July	3	60.00	2	40.00	5	4.17
	August	3	60.00	2	40.00	5	4.17

Reproduction. *Poecilus cupreus* is a spring-breading species, copulating in May and having a single generation per year (BURMEISTER, 1939; LINDROTH, 1949). It winters as adult and is found in agricultural ecosystems from April to September (our observations). In the wheat fields in Moldavia, the species was eudominant in 80% of the cases, and in the potato fields from Braşov in 45% of the fields. Adults are more active in May and June (wheat, Moldavia) and June, July (potato, Braşov and north Moldavia). At Iaşi, in the wheat field, Leţcani, many females with eggs were found between May 26 and June 6. According to our observations, *Poecilus cupreus* lays eggs intensely in the second half of May and in June.

According to NECULISEANU (2003), in the Republic of Moldova, *Poecilus cupreus* lays eggs in May-August, and young adults appear from June until October. According to BURMEISTER (1939) *Poecilus cupreus* is active from March to September. It lays eggs in May and June and new generation appears in August and September. These data are in accordance with our observations.

Preference for moisture. *Poecilus cupreus* is a mesophilous to moderately hydrophilous species. Conformable to our observations, *Poecilus cupreus* is much more abundant in crops with increased soil humidity (potato, sugar beet, clover, wheat). Similarly it prefers meadows in floodplains or also penetrates into disintegrated floodplain forests, where it indicates their deterioration (ŠUSTEK, 2001).

Preference for habitat. *Poecilus cupreus* is distributed in Europe and Siberia up to the Lena river (LINDROTH, 1949). According to our observations, the species lives in wet habitats from deteriorated floodplain forests, meadows, pastures, places with loamy or clay soils, agricultural crops (wheat, potato, sugar beet, sunflower, clover, apple orchards, sorghum). The species is mesohydrophilous to moderately hydrophilous and prefers habitats without closed woody vegetation. In places with sandy or gravely soils it is usually replaced by *Poecilus lepidus* (LESKE. 1785), while at higher altitudes by *Poecilus coerulescens* (LINNAEUS 1758).

In Moldova, *Poecilus cupreus* occurs in agrocoenoses, especially in those of wheat, potato, sugar beet, clover, where it was eudominant.

Food. The larvae and adults are zoophagous, according to (BASEDOW et al., 1976) an adult can eat up to 200 eggs of *Leptinotarsa decemlineata*; it also eats larvae of Tenthredinidae and aphids.

Sex ratio. In the wheat field at Zvorişţea in 1993, Moldova, and the potato field at Târgu Secuiesc in 1986, all individuals were sexed (Table 7). According to our data, the number of females is higher than that of males.

In the wheat field at Zvorişţea in 1993, among 1,441 individuals 493 were males (34.21%) and 948 were females (65.79%), thus, the females predominated 2.72 times.

In the potato field at Târgu Secuiesc in 1986, among 120 individuals, 32 were males (26.66%) and 88 were females (73.34 %), thus, the females predominated 2.75 times. Predominance of females was very stable in both crops during the whole collecting period, fluctuating within narrow limits of about 63 – 70 % in potato and in wider limits of 44 – 77 % in wheat, irrespectively of the decline of the total number of individuals in the subsequent months (Table 9). A striking predominance of females of the most abundant species was also observed in other Carabid communities living in ecosystems exposed to a moderate continuous stress, like agrocoenoses (NOVÁK, 1967; PETRUŠKA, 1971) or periurban ecosystems (ŠUSTEK, 1984). It seems that the predominance of females in the most abundant species represents a competitive advantage of these species allowing them to survive successfully in ecosystems exposed to cyclical stress factors, in the agroecosystems first of all to ploughing and harvesting. The enormous abundance of some Carabid species in such ecosystem indicates that they find in them, in spite of a strong cyclical stress, optimal conditions. This corresponds with the generally known fact that females, being responsible for the offspring, use to search the optimum conditions, while the males tend to prevail in pessimal conditions, being more moveable or explorative. In Carabids this was observed along different continuous ecological gradients (MÜLLER-MOTZFELD, 1970) or very centres of large cities ŠUSTEK (1984).

Dynamics. The numerical and percentage dynamics of the individuals of *Poecilus cupreus* in some potato fields are rendered in Fig 4. The dynamics was studied in two geographical regions – Ţara Bârsei region (Braşov in 1985 and 1986) and Târgu Secuiesc in 1986) and Moldova: Zvorişţea (1993, 1995), Dragomirna 1995. In the localities,

Braşov, 1986, Târgu Secuiesc 1986, Zvoriştea, 1993, and Dragomirna, 1995, the big majority of individuals was captured in May and June, 76.18% (Zvoriştea, 1993) and 93.85% (Dragomirna, 1995). In Braşov, 1985 and Zvorişea, 1995, the majority of individuals of *Poecilus cupreus* was captured in June and July: 64.81% (Zvoriştea, 1995) and 75.23% (Braşov, 1985). This corresponds with the spring reproduction of this species.

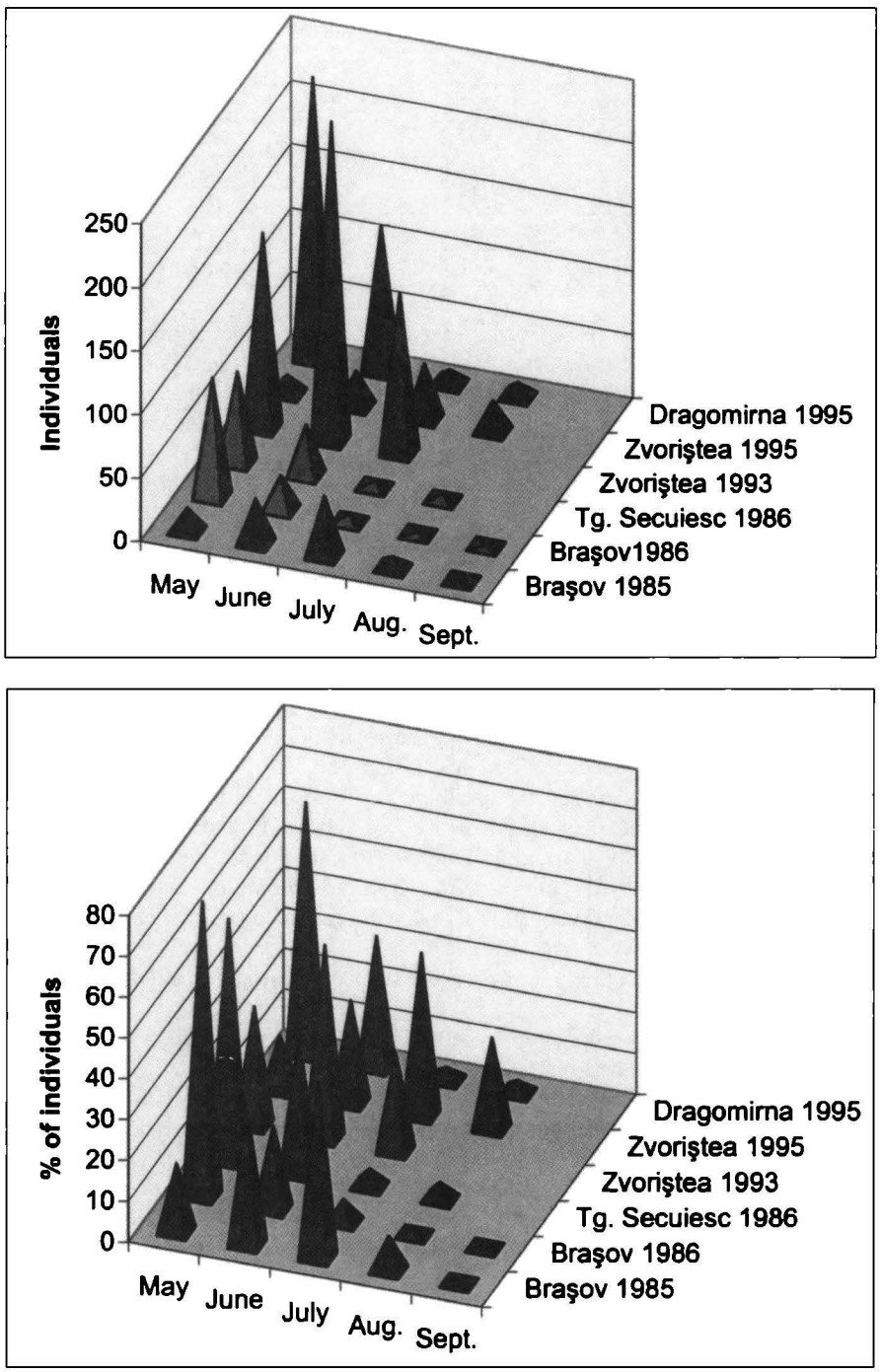


Figure 4. The seasonal dynamics of abundance and dominance of *Poecilus cupreus* in some potato fields.
Figura 4. Dinamica sezonieră a abundenței și dominanței speciei *Poecilus cupreus* în unele culturi de cartofi.

Distribution. *Poecilus cupreus* is distributed in the whole Europe and Siberia easterly up the Lena river (LINDROTH, 1949). In Romania, according to TEODOREANU (1970), the species was recorded in Muntenia, (Valea Prahovei), Transylvania (nine localities), Banat (one locality). During our systematic long-termed collecting in Moldova (VARVARA & BRUDEA, 1999; VARVARA, 2008; VARVARA & APOSTOL, 2008), this species was also observed in large quantities in maize (12 localities, from 1984 to 2000), sunflower (five localities 1982-1999), sugar beet (8 localities, 1987-2001), clover (3 localities 1977-1978, 2005).

In the Republic of Moldova (NECULISEANU, 2003), the species was recorded in seven crops (alfalfa, wheat, maize, soybeans, barley, sunflower, peas).

DISCUSSIONS

The considerable differences of climate in the compared zones, the dominance of *Poecilus cupreus* in wheat and potato fields strongly varies in regional, local, and between-year scale. In the wheat crop from Brăila County (Muntenia, south-east of Romania), *Poecilus cupreus* was collected only on one locality (Brăila), but in two pedologically different sites: Brăila, Terasă, with weakly salt soil (1981-1985, five years continuously) and Lacul Sărat with carbonated soil (1981-1984, four years continuously). The biggest number of *Poecilus cupreus* from these two sites was caught in 1983: Terasă, 235 (68.51% of all Carabids), Lacul Sărat, 3,210, (89.66% of all Carabids). The large quantity of individuals collected from Lacul Sărat had two causes, the carbonated chernozem and the increased soil humidity (the ground-water table was at the depth of 1.5 m (Table 4).

The three regions, Braşov, Moldova and Târgu Jiu basin, where the material was collected in potato fields, differ in average temperature and annual precipitations. At Braşov, annual average temperature is 7.8°C, Moldova 8.5°C, Târgu Jiu 10.2°C. The annual average precipitations are 548-782 mm (Braşov), 450-550 mm (Moldova) and 753 mm (Târgu Jiu).

Comparing our general data from the potato fields, the dominance of *Poecilus cupreus* is positively correlated with precipitations in these regions, at Braşov and north of Moldova, in comparison with Târgu Jiu basin, (Table 5 and Fig. 1 are conclusive). At Braşov, 39.75% of individuals of *Poecilus cupreus* were collected, whereas, 57.43% in Moldavia) while only 3.19% in Târgu Jiu. The collecting lasted 12 years at Braşov and 10 years at Târgu Jiu, but in Braşov the total catch was twelve times higher than in Târgu Jiu; in Moldova, the collecting lasted 10 years as in Târgu Jiu, but the total catch was 18 times higher than in Târgu Jiu. The main factor influencing the abundance of *P. cupreus* was the humidity of the habitat correlated with the precipitations in the region. In an integrated form this relationship is greatly expressed by the climatic complexes defined basing on the de Martone's aridity index (SĂVULESCU in KNECHTEL & PANIN, 1944). According to it, the localities near Târgu Jiu belong to the climatic complex of forests steppes to oak forests (aridity index 24-35), while those from Braşov to the complexes of beech or coniferous forests (aridity index 35-45).

The long-termed fluctuations of the population of *Poecilus cupreus* in two regions, Braşov and Moldova, are shown in figures 2 and 3. The fluctuations of the population from Braşov (Fig. 2) are almost regular, with sudden declines in occurrence in about 4-5 years intervals. The lowest catches were here recorded in 1997 and 1998 (Fig. 2), but the extremely low abundance in 1997 was accompanied by a medium dominance, hence this year was unfavourable for all Carabids, not only for *Poecilus cupreus* lowest dominance. The year 1998 was the warmest year of the study period. In this year both abundance and dominance dropped below the average values (Fig. 2). In Moldova, the population fluctuations of *Poecilus cupreus* were much less regular (Fig. 3) and rather a local then temporal character. The largest catch was recorded at Zvorişteа, 1993, because of the alluvial soil and humidity in the study site. The abundance and dominance were closely correlated here, unlike the years 1997 and 1998 in Braşov (Fig. 2). In both areas a tendency to decrease of population in 1997 and 1998 is obvious.

According to our data, the relative abundance of the species is high in 80% of localities (eudominant, wheat crops) and 45% (potato crops). Numerically, *Poecilus cupreus* is the second most abundant species in the wheat and potato crops after *Pseudophonus rufipes*. Also, it abundantly occurs in the sugar beet fields, where it was eudominant in 12 localities, 63% (from 19 localities, 1978-2001) (VARVARA, 2001).

Comparing our data with the quantitative collecting (BICA, 2005) from wheat fields from Banat region, four localities (1999-2002), big differences are observed: in Banat, *Poecilus cupreus* is subrecedent and recedent in wheat fields (1-4 individuals), while at Brăila and localities from Moldova, the species was eudominant in 80% of the localities.

In the European and Central European zoogeographical regions with continental temperate climate, the dynamics of a species has a genetically fixed seasonal character. *Poecilus cupreus,* winters as larva, passes into pupal stage in spring. In the potato fields most individuals (Braşov, 1986, Târgu Secuiesc, 1986, Dragomirna, 1995) occurred in May, when 59-71% of all individuals collected were captured, while in the locality Zvorişteа 1993, most individuals occurred in June (47%) and at Braşov, 1985 in July (43%). In the Republic of Moldova, according to NECULISEANU (2003), *Poecilus cupreus* is an eudominant species in the wheat fields, where its activity culminates in the first half of June, while in the maize fields, in July. These shifts of activity culmination can, of course, result from different temperature, but also from temporal shifts of presence of individual crops on the fields studied and from their maturity, which is other significant factor influencing microclimate in the stand interior and the crop attractively for Carabid species, inclusively *Poecilus cupreus*. As the winter wheat creates a developed closed stand already in the very spring or the spring wheat emerge very soon, the maize forms a closed stand as late as in early July, but unlike wheat stays on field until late autumn. Thus it can serve as refuge for Carabids leaving the harvested wheat field.

The females predominated in *Poecilus cupreus* similarly as in *Carabus scabriusculus* and *Carabus cancellatus* also were present in potato crops. Their predominance is interpreted as favourable to maintain a high population density; they successfully survive even under unsuitable existence conditions of ecosystems exposed to cyclical anthropogenic stress. It is reflected by its dominant or subdominant position in a major part of communities studied.

Seasonal dynamics is an ecological attribute of the species, its limits and the peak of activity is the result of the evolution and natural selection, being directly influenced by temperature. In *Poecilus cupreus*, in most cases, the peak of activity of the species, when most of individuals were captured, was in May and June, and in rare cases in June and July.

CONCLUSIONS

In spite that the field ecosystems are not the original natural habitat characteristic to *Poecilus cupreus*, it can successfully develop in post of them (wheat, potatoes, sugar beet, maize, sun flower, clover, sorghum, orchards), depending on their ecological conditions.

In wheat fields *Poecilus cupreus* appeared more frequent and its representation was less variable. It was recorded in the counties: Tulcea, Brăila, Bacău, Vrancea, Iaşi, Suceava, and Botoşani. Its dominance (within each community and years) varied between 1.21% (Perieni, 1989, Vaslui County) and 89.24% (Sârbi, 1999, Botoşani County). The species was eudominant in 20 localities (80.00%).

In the potato fields, *Poecilus cupreus* is less frequent and its representation was more variable. It was present in the counties: Argeş, Bacău, Botoşani, Braşov, Covasna, Dolj, Iaşi, Suceava, Tulcea. Its dominance varied between 1.46% (Braşov, 1991, Braşov County) and 68.52% (Vicovu de Jos, 1992, Suceava County). The species was eudominant in 33 localities (94.29%).The populations were strongly female dominated. The ratio between females and males was 1.92: 1 (wheat, Zvoriştea, 1993) and 2.75: 1 (potato, Târgu Secuiesc, 1986).

In most cases the seasonal activity dynamics culminated in May and June and in rarely in June and July.

AKNOWLEDGEMENTS

The material used in this paper was collected by a number of persons. It is a special pleasure for us to thank for it to Dr. Donescu Daniela from the Institute of Potato Crop Protection, Braşov, who assured the collecting of the material from the localities Braşov, Târgu Jiu, Mârşani and Tulcea; the former students of the Faculty of Biology: Budeanu Gabriela, Herghelegiu Simona, Mititiuc Mihaela, Sari Sabina, Ursachi Ramona; to the teachers from the pre-university education: Agachi Lucia, Antoniu Ioan, Dascălu Alexandru, Mărcuţă Costache, Paşa Virginia, Proca Constanţa, Radu Stratia, and Ştenţel Maria.

REFERENCES

BANIŢĂ EMILIA, COJOCARU DOINA, VOICU M., KIS B., CANTOREANU MARGARETA, LUCA EMILIA, PAULIAN MIHAELA, AFTENIE MARIANA. 1994. *Cercetări privind structura faunei dăunătoare şi utile în culturile de grâu din Oltenia.* Analele Institutului de Cercetări pentru Protecţia Plantelor Tehnice, Fundulea. Bucureşti. **61**: 169-182.

BASEDOW TH., BORG A., DECLERQ R., NIJVELDT W., SCHERNEY F. 1976. *Untersuchungen über das Vorkommen der Laufkäfer (Col., Carabidae) auf europäischen Getreidefeldern.* Entomophaga. **21**(1): 59-72.

BERINDEI MATEI. 1985. *Ghidul fermierului. Cultura cartofului.* Edit. Ceres. Bucureşti. 355 pp.

BICA VALERICA. 2005. *Cercetări asupra carabidelor din culturile de cereale cultivate în Câmpia de Vest.* Teza de doctorat. Universitatea de Ştiinţe Agricole şi Medicină Veterinară a Banatului. Timişoara (Forma electronică).

BURMEISTER F. 1939. *Biologie, Ökologie und Verbreitung der europäischen Käfer 1, Adephaga – Caraboidea.* Krefeld (Goecke und Evers). 206 pp.

CÂRLAN V. & VARVARA M. 1999. *The Fauna of Carabidae from two Agricultural Crops of Moldavia (Romania).* Analele Ştiinţifice ale Universităţii "Alexandru Ioan Cuza", Iaşi. Biologie animală. **64-65**: 83-92.

CHIRECEANU CONSTANTINA, MARGARIT G., JINGA V., PASCU GH., MANOLE D. 2009. *The Invertebrate Fauna Associated with the Wheat Agrocoenosis in Amzacea, Constanţa Counnty.* Romanian Journal for Plant Protection. Published by the Research-Development Institute for Plant Protection, Bucharest.

DONESCU DANIELA & ENOIU MARIA. 1995. *Lucrările celei de a doua Conferinţe Naţionale pentru Protecţia mediului prin metode şi mijloace biologice şi biochimice.* Universitatea Transilvania din Braşov: 66-75.

DUSHENKOV V. M. 1984. *Sezonnaya dinamika aktivnosti zhuzhelits v agrotsenozakh.* In: Fauna I Ekologia Bespozvonochnykh, Moskva: 69-76.

KABACIK-WASLIK DANUTA. 1970. *Ekologische Analyse der Läukäfer (Carabidae) einiger Agrarkulturen.* Ekologia Polska. **18**(7): 137-209.

KARPOVA V. E. 1984. *Vidovoi sostav i osobenosti raspredelinia zhuzhelits v agrotsenozah iuga Moldavii.* In: Fauna i Ekologhia bezpozvonocinih Jivotnih, Moskva: 82-86 [In Russian].

KIS B. 1970. *Raionarea zoogeografică a României pe baza faunei de Orthoptere.* Studia Universitatis Babeş-Bolyai. Biologia. Cluj-Napoca. **1**: 113-125.

KNECHTEL W. H. & PANIN S. A. 1944. *Oekologisch-zoogeographisches Studium an Coleopteren des Rumänisches Faunengebietes.* Etudes et recherché. Académie Roumaine. Bucharest. **25**: 1-225.

LINDROTH K. 1949. *Die Fennoskandischen Carabidae, I, Spezieller Teil.* Wettergren & Krebs Verlag, Göteborg. 711 pp.

MÜLLER-MOTZFELD G. 1970. *Der Sexual-Index bei Carabiden als ökologische Kriterium.* Entomologische Berichte. 14: 12-18.

NECULISEANU Z. 2003. *Carabidele (Coleoptera, Carabidae) din zona de interferenţă biogeografică (Taxonomie, Diversitate, Zoogeografie, Biologie) şi importanţa lor practică.* Teza de doctor habilitat în ştiinţe biologice. Chişinău. (manuscris). 260 pp.

NOVÁK B. 1967. *Veränderungen der Sexualindexes von Pterostichus vulgaris L in den Erdfallenfangen aus den Rübefeldern (Col. Carabidae).* Acta Universitatis Palackianae Olomucensis, Faculata. Rerum Naturalium, Series Biologica. **25**: 95-114.

PETRUŠKA F. 1971. *Vlyv pěstované plodiny na vývoj populací střevlíkovitých (Col. Carabidae).* Acta Universitatis Palackianae Olomucensis, Faculata. Rerum Naturalium, Series Biologica. **34**: 151-191.

POPESCU I. & ZAMFIRESCU S. 2004. *Synecological analysis of a wheat field ground beetles community from Letea (Bacău County).* Analele Stiinţifice ale Universităţii „Alex. I. Cuza", Iaşi. seria Biologie animală. **50**: 173-180.

PORHAJAŠOVÁ JANA, PETŘVALSKÝ V., ŠUSTEK Z., URMINSKÁ JANA, ONDRIŠIK P., NOSKOVIČ J. 2008. *Long-termed changes in ground beetle (Coleoptera. Carabidae) assemblages in a field treated by organic fertilizers.* Biologia, Bratislava. **63**(6): 1184-1195.

ŠUSTEK Z. 1984. *The bioindicative and prognostic significance of sex ratio in Carabidae.* Ekológia (ČSSR). 3: 3-22.

ŠUSTEK Z. 2001. *Restitution of carabid communities after catastrophic floods in floodplain forests.* In: Majerčák Juraj, Hurtalová Tatiana (Eds.): IXth International poster Day Transport of Water, Chemicals and Energy in the System Soil-Crop Canopy-Atmosphere, Bratislava 29.11.2001: 1-8.

TEODOREANU M. 1970. *Contribuţii la cunoaşterea răspândirii genului Pterostichus (Ord. Coleoptera, Fam. Carabidae) în România.* Studia Universitatis „Babeş-Bolyai", Biologie. Cluj-Napoca. **2**: 117-122.

TEODORESCU IRINA, VĂDINEANU A., SIMIONESCU A. 1999. *Managementul capitalului natural.* Studii de caz. Edit. ARS DOCENDI. Universitatea Bucureşti. 232 pp.

TIETZE F. 1973. *Zur Ökologie, Soziologie und Phänologie der Laufkäfer (Coleptera,Carabidae) des Gründlandes im Süden der D.D.R.* Hercynia. **2**: 111-126.

VARVARA M., DONESCU DANIELA, VARVARA V. 1990. *Contributions to the Knowledge of Carabid Beetles in Potato Crops in the Barsei Country.* Lucrările Simpozionului Entomofagii şi rolul lor în păstrarea echilibrului natural, Iaşi: 95-101.

VARVARA M., PISICĂ C., CÂRLAN V. 1991. *Contributions to the Knowledge tf Carabid Communities in Wheat Crops of Moldavia.* Proceedings of the ECE/**13**. SIEEC, GÖDÖLŐ: 818-823.

VARVARA M. 1991. *Abundenţa unor coleoptere epigee în cultura de grâu din Moldova.* Studii şi comunicări ştiinţifice (Secţia Biologie-Ecologie). Universitatea Bacău: 43-46.

VARVARA M. & MOGLAN I. 1993. *Contributions to the Study of Epigeic Coleoptera in three Biocoenoses of the Danube Delta.* Bulletin of the Academy of Agricultural and Forestry Sciences: 85-89.

VARVARA M., DONESCU DANIELA, DASCĂLU A. 1999. *Coenological Observations on the Populations of Carabidae (Insecta, Coleoptera) from some Potato Crops from Moldavia.* Analele ştiinţifice ale Univ. „Al. I. Cuza" Iaşi. **44-45**: 105-116.

VARVARA M. & BRUDEA V. 1999. The *Fauna of Carabidae (Coleoptera, Carabidae) in the Maize Crops from Moldavia.* Studii şi cercetări. Universitatea Bacău. 4: 79-84.

VARVARA M. & BULIMAR FELICIA. 2003. *Long-Term Faunistic and Ecological Research of Carabid Communities (Coleoptera, Carabidae) In the Winter Wheat Crops From Eastern Romania.* Complexul Muzeal de Stiinţele Naturii „Ion Borcea". Studii şi comunicări. Bacău: 143-150.

VARVARA M. 2001a. *Observations on the Carabid Coenosis (Coleoptera, Carabidae) in the Potato Crops from Suceava District.* Simpozionul Jubiliar Consacrat Aniversării a 30 ani de la Formarea Rezervaţiei „Codrii", 27-28 Septembrie, Chişinău. **2**: 78-79.

VARVARA M. 2001b. *Variation of Diversity of Carabidae (Coleoptera, Carabidae) in some Potato Crops from Romania.* Analele Ştiinţifice. Universitatea „Alexandru Ioan Cuza", Iaşi. **47**: 53-63.

VARVARA M. 2003. *Aspects of Knowledge of Numerical Variations and Biodiversity of Epigeic Invertebrates in the Forest Ecosystem of Poplars from Moldavia (Eastern Romania).* Analele ştiinţifice ale Universităţii „Alexandru Ioan Cuza" Iaşi, seria Biologie animală. **49**: 7-17.

VARVARA M. 2005. *The Taxonomic and Ecological Spectra of Carabids (Coleoptera, Carabidae) In Three Agrocoecosystems from Moldavia.* Lucrările Simpozionului Entomofagii şi rolul lor în păstrarea echilibrului natural. Universităţii „Al. I. Cuza", Iaşi: 131-146.

VARVARA M. 2008. *The Diversity and Main Ecological Requirements of the Epigeic Speciies of Carabidae (Coleoptera, Carabidae) in the Ecosystem Crop of Sugar Beet from Moldavia, 1981–2001.* Lucrările Simpozionului Entomofagii şi rolul lor în păstrarea echilibrului natural, Universitatea „Al. I. Cuza", Iaşi: 175-192

VARVARA M. & APOSTOL E. 2008. *Diversity and the Main Ecological Requirements of the Epigeic Species of Carabidae (Coleoptera, Carabidae) in the Sun Flower Ecosystem, Broscauti (Botoşani County).* Analele ştiinţifice ale Universităţii „Al. I. Cuza", Iaşi. Biologie animală. **54**: 8-89

VARVARA M. 2011. *Distribution and the Relative Abundance of the Species Pseudophonus rufipes De Geer (Coleoptera, Carabidae) in some Wheat and Potato Crops in Romania, 1977-2002.* Analele ştiinţifice ale Universităţii „Al. I. Cuza", Iaşi, seria Biologie animală. In press.

VARVARA M. 2011. *Distribution and the Relative Abundance of the Species Pterostichus melanarius Illiger 1798 (Coleoptera, Carabidae) in some Wheat and Potato Crops in Romania, 1977-2002.* Analele Stiinţifice ale Universităţii „Al. I. Cuza", Iaşi, seria Biologie animală. In press.

Varvara Mircea
"Alexandru Ioan Cuza" University, Faculty of Biology
Bd. Carol I, 20 A, 700506 Iaşi, Romania
E-mail: mvarvara@uaic.ro

Šustek Zbyšek
Institute of Zoology, Slovak Academy of Sciences,
Dúbravská cesta 9, 845 06 Bratislava, Slovakia,
E-mail: zbysek.sustek@savba.sk

Received: March 24, 2011
Accepted: August 2, 2011

STUDIES ON STAPHYLINIDAE BELONGING TO THE GENUS *Carpelimus* LEACH, 1819 (COLEOPTERA: STAPHYLINIDAE: OXYTELINAE FLEMING, 1821) FROM BULGARIA

RAYCHEV Ivan

Abstract. A review of the studies on the species from *Carpelimus* 1819 in Bulgaria is made. Twelve species, two of them new for the fauna of Bulgaria are reported – *C. despectus* BAUDI, 1870 and *C. politus* KIESSENW, 1850. The common incidence of the species is specified.

Keywords: Insecta, Coleoptera, Staphylinidae, Oxytelinae, *Carpelimus* LEACH.

Rezumat. Studii asupra genului *Carpelimus* LEACH, 1819 (Coleoptera: Staphylinidae: Oxytelinae FLEMING, 1821) din Bulgaria. Se face o analiză a studiilor asupra speciilor genului *Carpelimus* LEACH, 1819 din Bulgaria. S-au identificat douăsprezece specii, dintre care două sunt noi pentru fauna Bulgariei - *C. despectus* BAUDI, 1870 şi *C. politus* KIESSENW, 1850. Este specificată incidenţa comună a speciilor.

Cuvinte cheie: Insecta, Coleoptera, Staphylinidae, Oxytelinae, *Carpelimus* LEACH.

INTRODUCTION

According to the data of HERMAN (2001), 414 Staphylinidae species found in all continents but mainly in the Neotropical, Ethiopian and Palaearctic zoogeographical zones belong to *Carpelimus* LEACH, 1819 genus (also widely known under the synonym *Trogophloeus* MANNERHEIM, 1830).

The objective of this paper is to systematize the data currently known for the species composition and incidence from *Carpelimus* genus in Bulgaria, as the available information is fragmented and some of the species are reported with their synonyms.

MATERIAL AND METHODS

The species nomenclature and their incidence are presented in compliance with the latest data in the world catalogue of HERMAN (2001) group. Thus, some additional notes are necessary for this paper, as they are given at the end of the species list.

RESULTS AND DISCUSSIONS

Representatives of this genus for the Staphilinidae fauna in Bulgaria were mentioned for the first time by RAMBOUSEK (1909). He described 10 species from *Trogophloeus* genus – synonym of *Carpelimus*. It was the first fundamental work for our country, including representatives of this genus; however, some of the reported names later became synonyms.

The publication of SCHEERPELTZ (1937) followed with information about 3 species, but two of them were already described by RAMBOUSEK and these were all the data for the species of *Carpelimus* genus for Bulgaria.

Thus, according to the literature 10 species of the genus *Carpelimus*, had been reported for Bulgaria, to the present publication, as their habitats were found mainly in South Bulgaria and along the Black Sea coast.

After the explorations undertaken by the author for many years, mostly in the northern part of the country, 2 new species for our fauna belonging to this genus were found – marked with an asterisk in the text; thus, their total number for the country increased to 12 species, described below in alphabetical order:

1. ***Carpelimus bilineatus*** STEPH., 1834 – first reported by RAMBOUSEK (1909) as common for the country and by SCHEERPELTZ (1937) for the region of Varna. It was also found on Persina Island, near the town of Belene, the Danube River, near the Dead Swamp, with light trap at night, July 17-18, 1981, 4 specimens and June 25-27, 1982, 7 specimens; in the outflow of the Vit River near the village of Somovit, June 13, 1985, along the banks of the Danube River and the Vit River, 11 specimens.

Incidence – almost the entire Holarctic zone, further in Chile, Australia and New Zealand.

2. ***Carpelimus corticinus*** GRAV., 1806 – first reported in the collection of the Museum of Natural History in Sofia City - Coll. MHNS, then by RAMBOUSEK (1909) - common and ARNDT (1943) for the region of Plovdiv and Lakatnik railway station.

Incidence – almost entire Europe, North Africa, Russia, Turkey, Iran and North India, North and Central America.

3.* ***Carpelimus despectus*** BAUDI, 1870 – Found also on Persina Island, near the town of Belene, the Danube River, near the Dead Swamp, with light trap at night, July 17-18, 1981, 4 specimens and June 24-27, 1982, 11 specimens.

Incidence – entire Europe, Russia, the Caucasus, Turkey, Syria and Iran to Central Asia and Nepal.

Note - species *despectus* BAUDI, 1870 = *despectus* MULSANT and REY, 1870.

4. ***Carpelimus elongatulus*** ER., 1839 - reported by RAMBOUSEK (1909) - the vicinity of St. German Monastery.

Incidence – spread in entire Europe, including the Scandinavian Peninsula, Russia and Georgia - the Caucasus.

5. ***Carpelimus exiguus*** ER., 1839 – reported by RAMBOUSEK, 1909 for the area along the Tunja River and the region of Burgas. Found also on Persina Island, near the town of Belene, the Danube River, near the Dead Swamp, with light trap at night, July 17-18,1981, 7 specimens and June 25-27, 1982, 12 specimens.

Incidence – according to GILDENKOV (1998b) outside the frames of Palearctic zone, it could be met also in North and Central Africa, Indonesia, Malaysia and Australia.

6. ***Carpelimus gracillis*** MANNERH., 1830 – reported only by RAMBOUSEK (1909) for the area along the Tunja River.

Incidence – Europe, the Mediterranean area, Russia, the Caucasus, Mongolia and North America.

7. ***Carpelimus memnonius*** ER., 1840 – reported by RAMBOUSEK (1909) for the regions of Burgas, Varna, the area along the Tunja River and Stralja, and by ARNDT (1943) for the area along the Maritsa River, near the town of Plovdiv. Found also along the Vit River, the old riverbeds, near the village of Gradina, June 18, 1997, 3 specimens and the river valley between the villages of Tarnene and Yasen, July 23, 2001, on slimy riverside strips, 2 specimens.

Incidence – the entire Mediterranean zone, North Africa, Russia, the Caucasus, Uzbekistan, to the West India, North America and Mexico.

8. ***Carpelimus nitidus*** BAUDI, 1848 – reported by RAMBOUSEK (1909) only for the region of Varna. Found also on Persina Island, near the town of Belene, the Danube River, near the Dead Swamp, with light trap at night, July 17-18, 1981, 2 specimens and June 25-27, 1982, 3 specimens.

Incidence – Europe, excluding the Scandinavian Peninsula, the Mediterranean zone, North Africa, Russia, Ukraine and the Caucasus.

9. ****Carpelimus politus*** KIESSENW., 1850 – Found on Persina Island, near the town of Belene, the Danube River, near the Dead Swamp, with light trap at night, July 16-18, 1981, 18 specimens and June 24-27, 1982, 13 specimens.

Incidence – entire Europe and the Mediterranean zone, North Africa, the Caucasus, South-west and Central Asia to Mongolia.

10. ***Carpelimus punctipennis*** KIESSENW., 1850 – reported in HORION (1963) Catalogue for Bulgaria, without specifying the habitat.

Incidence - Europe, excluding the Scandinavian Peninsula, the Mediterranean zone, Russia, Ukraine and Uzbekistan.

11. ***Carpelimus pusillus*** GRAV., 1802 – reported by RAMBOUSEK, 1909 only for the vicinities of Sofia City.

Incidence - entire Europe and the Mediterranean zone, Russia, Ukraine and the Caucasus, North Africa, Turkey, New Zealand and North America.

12. ***Carpelimus rivularis*** MOTCH., 1860 – reported by RAMBOUSEK, 1909 for the vicinities of the town of Sliven and by SCHEERPELTZ (1937) for the region of Varna.

Incidence – according to HORION (1963) in the entire Palaearctic zone. It was reported by CASEY (1889) for the USA, too – North Carolina as a new species of *Troglophloeus spretus* CASEY 1889, which later was derived by BERNHAUER & SCHUBERT (1911) as a synonym of *rivularis* MOTCH., 1860.

CONCLUSIONS

The species of *Trogophloeus* (*Carpelimus) bodemeyeri* BERNH., 1902 – reported by SCHEERPELTZ (1937) for Mount Yumrukchal, 1 400 m altitude was reassigned (HERMAN, 1970) to the genus *Thinodromus* KRAATZ, 1857, i.e. at present it is *Thinodromus bodemeyeri* BERNH., 1902.

The species of *Trogophloeus dilatatus* ER., 1839 reported by RAMBOUSEK (1909) for Pancharevo was reassigned too in the genus *Thinodromus* – published by HERMAN, 1970, i.e. at present it is *Thinodromus dilatatus* ER., 1839.

REFERENCES

ARNDT W.1943. *Beitrage zur Kenntnis des Susswacerfaune Bulgarien.* Annals of the Institute of Natural History. Sofia. **16**: 214-218.

BERNHAUER M. & SCHUBERT K. 1911. *Staphylinidae II.* In S. Schenkling, Coleopterum Catalogus. Berlin: Junk. **5**(29): 87-190.

CASEY T. L. 1889. *A preliminary monograph of the North American species of Trogophloeus.* Annals of the New York Academy of Sciences. **4**: 322-383.

GILDENKOV M. I. 1998. *Carpelimus minimus (Kraatz, 1859) as a proprius species with a key to the Oriental species of the subgenus Troginus (Coleoptera, Staphylinidae, Carpelimus).* Russian Entomological Journal. 7: 127-128.

HERMAN H. LEE. 2001. *Catalog of the Staphylinidae (Insecta, Coleoptera) 1758 to the End of the Second Millennium, t. III, Oxytelinae group.* Bulletin of the American Museum of Natural History. New York: 1307-1805.

RAMBOUSEK F. 1909. *Sur les staphylinides de Bulgarie.* Vestnik Kral. Cesk. Spol. Nauk v Prahe. **2**(4): 1-23.

SCHEERPELTZ O. 1937. *Wissenschäftlische Ergebnisse einer von Herrn Hofrat F. Scheübert, seinem Sohne Herrn cand. Phil. F. Scheübert und Herrn Prof. K. Mandl im Sommer 1935 (1936) nach Bulgarien unternemmenen Studienreise.* Annals of the Institute of Natural History. Sofia. **10**: 283-292.

Raychev Ivan
Regional Historical Museum, Section "Nature"
"St. Zaimov" Str., No. 3, 5800 Pleven
E-mail: iraich@abv.bg

Received: March 16, 2011
Accepted: August 4, 2011

INFESTATION OF THE MEDICINAL PLANT *Sedum telephium* L. (CRASSULACEAE) BY THE WEEVIL *Aizobius sedi* GERM. (COLEOPTERA: CURCULIONOIDAEA: APIONIDAE) IN THE KARST REGION OF OLTENIA (SOUTH OF ROMANIA)

BÂRCĂ Valentin, NICULAE Marilena

Abstract. *Sedum telephium* L. is a succulent medicinal plant widely used in traditional medicine in Europe. Investigating the opportunity of its intensive culture in the karst region of Oltenia, we gathered data about the frequency and range of this plant's infestation by one of its documented herbivores, *Aizobius sedi* (GERMAR) which is a steno-monophagous black weevil, feeding on Crassulacean leaves and stems. Its Romanian range has not been documented yet. We hereby present for the first time for Romania, a list of locations where *A. sedi* was found to inflict damage to native plants *S. telephium*, complemented by a gridmap in UTM projection system of the species infestation in Oltenia karst region. The region involved in our study comprises a variety of habitats based on limestone substrate spanning North of Danube between 22°30'E - 24°30'E meridians, and the 44°40'N - 45°40'N parallels; situated approximately between km 4900-5040N of the UTM projection zones 34 and 35. We also present some considerations about the chorology and ecology of the species with reference to biotic and abiotic factors involved in its distribution, its sozological status in Romania and its potential to become a pest of *S. telephium* in medicinal intensive cultures.

Keywords: *Sedum telephium, Aizobius sedi,* Infestation, Karst habitats, Oltenia, Romania.

Rezumat. Infestarea plantei medicinale *Sedum telephium* L. (Crassulaceae) de către gărgăriţa *Aizobius sedi* GERM. (Coleoptera: Curculionoidaea: Apionidae) în regiunea carstică a Olteniei (sudul României). *Sedum telephium* L. este o plantă medicinală suculentă larg folosită în medicinele tradiţionale din Europa. Investigând posibilitatea şi oportunitatea cultivării ei intensive în subcarpaţii Olteniei, am strâns date despre frecvenţa şi aria infestării acestei plante de către unul din ierbivorii ei cunoscuţi, *Aizobius sedi*, - o gărgăriţă steno-monofagă, care se hrăneşte pe frunze şi tulpini de crassulacee. Aria de răspândire în România nu a fost detaliată până acum. Prezentăm aici în premieră pentru România, o listă a localităţilor unde a fost găsită *A. sedi* producând pagube la plante spontane de *S. telephium*, completată de o hartă raster în proiecţie UTM a infestării acestei specii în carstul Subcarpaţilor Olteniei. Regiunea cercetată cuprinde o varietate de habitate pe substrate calcaroase situate la nord de Dunăre, între meridianele 22°30'E - 24°30'E, şi paralelele 44°40'N - 45°40'N; aproximativ între km 4900-5040N ai zonelor 34 and 35 ale sistemului de proiecţie UTM. De asemenea prezentăm unele consideraţii despre corologia şi ecologia speciei, referitoare la factorii biotici şi abiotici implicaţi în distribuţia ei, statutul ei sozologic în România şi despre potenţialul ei de a deveni un dăunător la *S. telephium* în culturi medicinale intensive.

Cuvinte cheie: *Sedum telephium, Aizobius sedi*, infestare, habitate carstice, Oltenia, România.

INTRODUCTION

Sedum telephium L. was widely used since immemorial times in temperate Eurasia in traditional medicine (as also other members of Crassulaceae family) as a therapeutic plant. The aerial parts of the plant are used as source for the active compounds, in contrast with *Rhodiola rosea*, for example, in which the drug is obtained from the (dried) roots. It was traditionally well appreciated for its local anti-inflammatory and analgesic effect. The fresh, instantly peeled leaves, or their juice, applied on wounds and burns promote wound healing and reduce inflammation and pain in local inflammatory skin diseases (DATTNER, 2004; BALATRI, 1981; SENDL et al., 1993).

It has been convincingly argued that the therapeutic activity of *S. telephium* is due to its rich content of polysaccharides and flavonol glycosides (mainly quercetin and kaempferol) (MULINACCI et al., 1995; BONINA et al., 2000; ALTAVILLA, 2008). As a result of a larger body of work investigating the possibility and opportunity of intensive culture of this plant in the karst region of Oltenia, we gathered data about the frequency and range of infestation of this plant by one of its documented herbivores, *Aizobius sedi.*

Aizobius sedi is a small black weevil belonging to the family Apionidae (Curculionoidaea). The species, described by Germar in 1818, from leaves of *Sedum telephium* L., as *Apion (Perapion) sedi* it was first mentioned in 1912 in Romania by PETRI (leg. A. Ormay, from Salzburg, Transylvania).

To this date, there is no scientific paper describing the complete distribution range of *Aizobius sedi* in Romania. Our study is a first attempt to fill at least part of this knowledge gap by providing data about the infestation area of *S. telephium* by *A. sedi* in Oltenia.

The host plants reported in the available literature for *A. sedi* (Apionidae), is given below [with the number of sources for this interaction put in brackets], (for a list of references see BRC website; accessed march 2011) *Sedum anglicum* [1], *Sedum telephium* ssp. *purpurascens* [1], *Sedum telephium* [2], *Sedum reflexum* [2], *Sedum album* [3], *Sedum sexangulare* [2], *Sempervivum arachnoideum* [1], *Sedum forsteranum* [1], *Sempervivum tectorum* [1], *Sedum* [1], *Sedum acre* [3].

According to Fauna Europaea (2007), the general distribution spans from the United Kingdom and European Atlantic coast (except Luxembourg and Ireland) into Ukraine and from Scandinavia and Finland to the Mediterranean shores of Spain and Italy (though failing to be reported form the Mediterranean islands, Balkan Peninsula and offshore Greece).

S. telephium is a perennial Crassulacean species giving off every spring several erect annual shoots. The densely foliated annual shoots wither and die out that following autumn, after producing copious quantities of seeds. Morphologically, it is characterized by erect follicles, pentamerous sessile flowers with white, yellow-greenish petals, grouped in terminal and axillary inflorescences. The leaves are glaucous-green, subsessile, often subcordate to semi-amplexicaule. Inflated tuberiform roots, lacking leaf scales, also characterize it. *S. telephium* is a very polymorphic species, displaying a wide variation in many characters such as leaf contour, shape and phylotaxis, nectarial scales and floral morphology in general.

The taxonomy and systematics of *S. telephium* is complex and confuse, reflecting the two opposing tendencies, namely: segregation into several minor taxa, or conglomeration of highly variable taxa into (more) complex taxonomic units, -as viewed by Linne who described the species in 1753 (LINNAEUS, 1753).

Ravarut, the taxonomist of the genus in Romania treated it in the monumental work Flora R.P.R. (RĂVĂRUȚ, 1953) *S. telephium* L. as *S. maximum* (L.) HOFF.

To circumvent the contradicting opinions around the taxonomical ranking of the studied plants and as the taxonomical discussion of the Romanian *S. telephium* populations is beyond the scope of this paper and it will be discussed in more detail elsewhere (BÂRCĂ & NICULAE, in prep.).

S. telephium L has a wide, Palaearctic distribution, it is widely distributed throughout Romania, mainly at higher altitudes, the species inhabiting dryer habitats in stony places showing though a large ecological amplitude.

From an ecological point of view, in the locations of the studied region, *S. telephium* is a thermophilous saxicolous xerophyte, usually preferring fertile soils like rendzina rich in humus and calcium carbonate, that have developed over well-drained limestone bedrock, although it shows considerable ecological amplitude like *Sedum hispanicum* L., and *S. anuum* L. - other Crassulaceans with which it is often associated in the region (NICULAE & BÂRCĂ, 2005; NICULAE & BÂRCĂ, 2006). According to BORZA (see comments in BORZA A. FRE no2433b), is distributed ubiquitously, relatively often in humid, shady and densely wooded locations, but often found in very dry, sunny, south-exposed rocks, gravel, and stony places in scrubs, and southern open *Quercus* woods but also on stonewalls and on roadsides. Its altitudinal range spans from virtually sea level to over 2000 m *s.m.* According to our observations, in Romania, *S. telephium* L. shows wide ecological amplitude, flourishing in many habitats.

The region involved in our study extends North of Danube being limited to the South approximately by the 44°40'N parallel and the 45°40'N parallel to the North and spanning between 22°30' E meridian to the West and 24°30' E meridian towards East. It comprises the mountains situated approximately between km 4900-5040N of the UTM projection zones 34 and 35.

The studied region comprises a wide variety of habitats based on limestone substrate from the Danube flood plains towards the barren peaks in the Romanian Carpathian Mountains (an altitude ranging between 50-1550m asl.),

The climate is extreme continental characterized by wide annual and diurnal variations in temperature and rainfall, but with remarkable thermophilous habitats on the limestone substrates the region showing also similarly diverse ground cover and edaphic conditions.

The objective of this study was to provide a preliminary overall image of the actual infestation range of *A. sedi* on *S. telephium* in the Oltenia karst region of the Southern Carpathians. Our study presents a list of the localities where we have positively found *A. sedi* on *S. telephium*, complemented by a raster map in the UTM projection system of this species' distribution in Oltenia together with some considerations about the chorology and ecology of the species with regard to biotic and abiotic factors influencing this distribution.

MATERIAL AND METHODS

Host plant identification:

Due to its high morphological variability and its poorly defined taxonomy, *S. telephium* is a difficult species to positively identify. For practical reasons, to improve precision of fieldwork identification and because we have found the weevil on several species (see above and discussions), we have adopted the following diagnostic criteria to include individual plants in this study:

- Hermaphrodite, pentamerous flowers without red (ish) pigments in the petals;
- Flowers without red (ish) pigments in the petals;
- Leaves at least partially sessile to semi-amplexicaul and opposite;
- Inflated rhizomatous "roots", without persistent foliar scales.

At this stage, we have used these criteria, leaving for a later moment the task to ascertain beyond any doubt the assignment of the plant specimens or populations to *S. telephium* or to some other related taxa.

Infestation diagnosis:

The diagnostic criteria used to consider a positive infestation with *A. sedi* were the following:

- adults actually present on the plan;
- characteristic lesions present on the plan.

When the actual presence of *A. sedi* on the host plant could not be ascertained (for the herbarium specimens of *S. telephium* examined, as well as for 9 specimens in 5 locations seen by us), and the characteristic lesions were present on that individual, we used the absence of ceccidial swellings on the shoot stems as the distinguishing criterion to rule out the unlikely possibility of confusion with *Pericartiellus telephii* BEDEL, another weevil feeding on *S. telephium*

Although *P. telephii* adults produce similar lesions as *A. sedi,* the larvae produce characteristic ceccidial stems swellings in which the larvae develop and pupate, fact which we used as distinguishing element.

Geographical characteristics:

To establish the UTM geo-codes for the locations cited we have used when applicable Lehrer's work (LEHRER & LEHRER, 1990) on the cartography of Romanian fauna and flora using arealographic coordinates or geo-codes derived from GPS coordinate readings from surveys done by the authors. The UTM geo-codes were given when possible for the closest human settlement available.

For each location cited we have mentioned citation sources and the name under which the host plants were identified (for herbarium specimens) by each author when it differed from the species name accepted. Due to the limited space available and because this was not the objective of the present study, we do not give in this report data like collection dates, ecological and phyto-sociological information which will form the object of a future article.

RESULTS

Our results comprise a number of 44 locations from which plants of *S. telephium* were found infested by *A. sedi.* Out of these, a number of 6 locations are derived from herbarium plant specimens collected before 2010, that show clear, specific feeding lesions made by the adult *A. sedi* that could not be confirmed by our fieldwork (as shown in Fig. 2B), and a number of 38 are new locations or older locations in which the presence of *A. sedi* on *S. telephium* L., was positively confirmed by us. The data are presented below in tabular format (Table 1). The sites that could be positively located on the map are presented in figure 1, in a convenient format on a map with UTM quadrants and the hydrographic system. We have indicated the sites cited using different symbols for the two data subsets, of which the most important is the subset comprising the sites in which the presence of the species was positively confirmed by us. For reference, we have given in the table, the years when we have observed the plants in the mentioned sites, as follows in figure 1.

Table 1. Locations list where *S. telephium* L. plants were found infested by *Aizobius sedi.*
Tabel 1. Lista localităţilor unde au fost găsite plante de *S. telephium* L. infestate de *Aizobius sedi.*

No.	County	Location and Altitude (a.s.l.)	UTM Geo-code	Information Source**
1	CS	Ciorici near, Băile Herculane, limestone rocks	FQ16	(B 93)
2	CS	Pecinişca near Băile Herculane, limestone rocks	FQ16	(B 92-01)
3	CS	Băile Herculane (across from the old firestation, in the woods)	FQ17	(B 95)
4	CS	Mt. Domogled near, Băile Herculane 1060 m	FQ17	(B 93-99) (B&N 03)
5	CS	Cerna valley, left side	FQ18	(B 95)
6	CS	Valea Ţesnei lower course	FQ18	(B&N 99, 00) (B 08)
7	CS	Jidostiţa	FQ25	(B 93)
8	CS	Gornenţi	FQ27	(B 93)
9	GJ	Isverna, close to the entrance to "Isverna cave"	FQ28	(B 10)
10	GJ	Godeanu	FQ38	(B 95)
11	GJ	Cerna Sat	FQ39	(B95)
12	GJ	Ţesna Valey, upper course	FQ39	(B 95)
13	GJ	Valea Găinii, near Baia de Aramă, alt cca 350 m a.s.l. Leg Prodan, Buia, et al 13 Aug 1954 *sub Sedum maximum* SUTER	FQ48	CRA
14	GJ	Cloşani	FQ49	(B 93)
15	GJ	Motru Sec on limestone rocks	FQ49	(B 92)
16	GJ	Bordul Dobriţei/Runcu at the base of limestone cliffs	FQ69	(B 92)
17	GJ	Cantonul Dragomanu/Runcu, in the woods	FQ69	(B 92)
18	GJ	Cheile Sohodolului/Runcu on limestone rocks, near "la Nări" caves	FQ69	(B 92)
19	GJ	Cheile Oltetului close to peştera Polovragi (Polovragi cave)	GR00	(B 04)
20	GJ	Polovragi, Cheile Ţiriei	GR10	(B 04)
21	MH	Insula Ada-Kaleh, Tr. Severin, alt cca. 210 m asl. Leg Buia, Olaru, Cărţu, Popescu Sept. 30, 1965 *sub Sedum maximum* SUTER	FQ----	CRA
22	MH	Orşova, behind the railway station, in the woods	FQ05	(B 93)
23	MH	Cazanele Dunării, alt 150-200m asl. Leg Buia, Păun et Maloş, 9 Jul 1959 sub *Sedum maximum* SUTER	FQ15	CRA, (B 03)
24	MH	Vârciorova dry woods, on schistose bedrock, alt cca. 100m a.s.l. leg. Borza et Buia Sept. 19, 1941 [sub *S. maximum* (L.) SUTER]	FQ15	CRA
25	MH	Vârciorova dry woods, on schistous bedrock, alt cca. 100m a.s.l. leg. Borza et Beldie Sept. 19, 1941 sub *Sedum maximum* SUTER	FQ15	FRE 2433b. in HTgMs, in HBV, HCJ (B 93)
26	MH	Pecinişca	FQ16	(B 93)
27	MH	Balta Cerbului	FQ18	(B 93)
28	MH	Gura Văii	FQ24	(B 93)
29	VL	Râmnicu Vâlcea	KK99	(B 04, B 09)

30	VL	Valea Bistriței on Mt. Govora, alt cca. 1700m a.s.l. Leg. et det. Gh Popescu, sub *Sedum maximum* SUTER	KL60	CRA
31	VL	Valea Cheii, (between [schitul] Iezer and the canyon) Oct. 4, 1951 leg. D. Tătăranu [sub. *S. maximum* SUTER]	KL70	HBV
32	VL	Buila Mts., Claia Strâmbă-Livada cu Mesteceni	KL71	(B 88, B 89, B 91), (B&N 97)
33	VL	Buila Mts., in Valea Cheii, by the lower exit of the canyon	KL71	(B 91)
34	VL	Buila Mts., Mt. Stogşoare, on "Scocul Ursului"	KL71	(B 88, B 89, B 1), (B&N 97)
35	VL	Buila Mts., Mt. Stogşoare, on the stonewalls by the tunnel	KL71	(B 88, B 89, B 1), (B&N 97)
36	VL	Buila Mts, near "Cuptorul de var", by the lower exit of the canyon	KL71	(B 91)
37	VL	Buila Mts., Santinela Cheii	KL71	(B 88, B 89, B 91)
38	VL	Buila Mts., Valea Cheii, Brâna Caprei	KL71	(B 91)
39	VL	Olăneşti Băi, around the baths, Sept 25 1952, leg. Buia et Păun	KL80	CRA
40	VL	Cozia Monastery on the ramparts towards River Olt	KL81	(B 01)
41	VL	Turnu Monastery on the rock "La chilie"	KL81	(B 97), (B 02-05), (B 09-10)
42	VL	Brezoi, up the valley, on rocks and by the fall	KL82	(B 07)
43	VL	Valea Oltului, left shore, above Turnu Monastery on the railway tunnels roof and on the cliffs	KL82	(B 93, B 04)
44	VL	Cascada Stânişoara, on rocks by the fall Stânişoara Monastery, Towards Cozia Peak, on rocks	KL91	(B 97)

Symbols/Legend: * **UTM geo-codes** were given when possible for the closest human settlement available, when the locations could not be precisely located, we have only indicated the 100 km square geocodes / **Codurile UTM** au fost date pentru cele mai apropiate aşezări umane, în lipsă am indicat doar geocodul pătratului de 100 km.

County acronyms/prescurtările judeţelor: CS = Caraş-Severin, GJ = Gorj, MH = Mehedinti, VL = Vâlcea

**collector's name and observation year of *A. sedi* on *S. telephium* L. are mentioned. / Sunt menţionate numele colectorului şi anul (sau anii) în care *A. sedi* a fost observat pe *S. telephium* L.(BN + XX) = (Bârcă & Niculae + the last 2 digits of the year when the weevil was found on the plant) *e.g.* (BN 04) = (BÂRCĂ & NICULAE, 2004) (B + XX) = (Bârcă + the last 2 digits of the year when the weevil was found on the plant *in situ*)

HBV = Herbarium of Univ. Braşov; HCJ = Herbarium of Univ. Cluj-Napoca; HTgMs = Herbarium of Univ. Med Pharm Tg. Mureş;
CRA = Herbarium of Univ. Craiova.

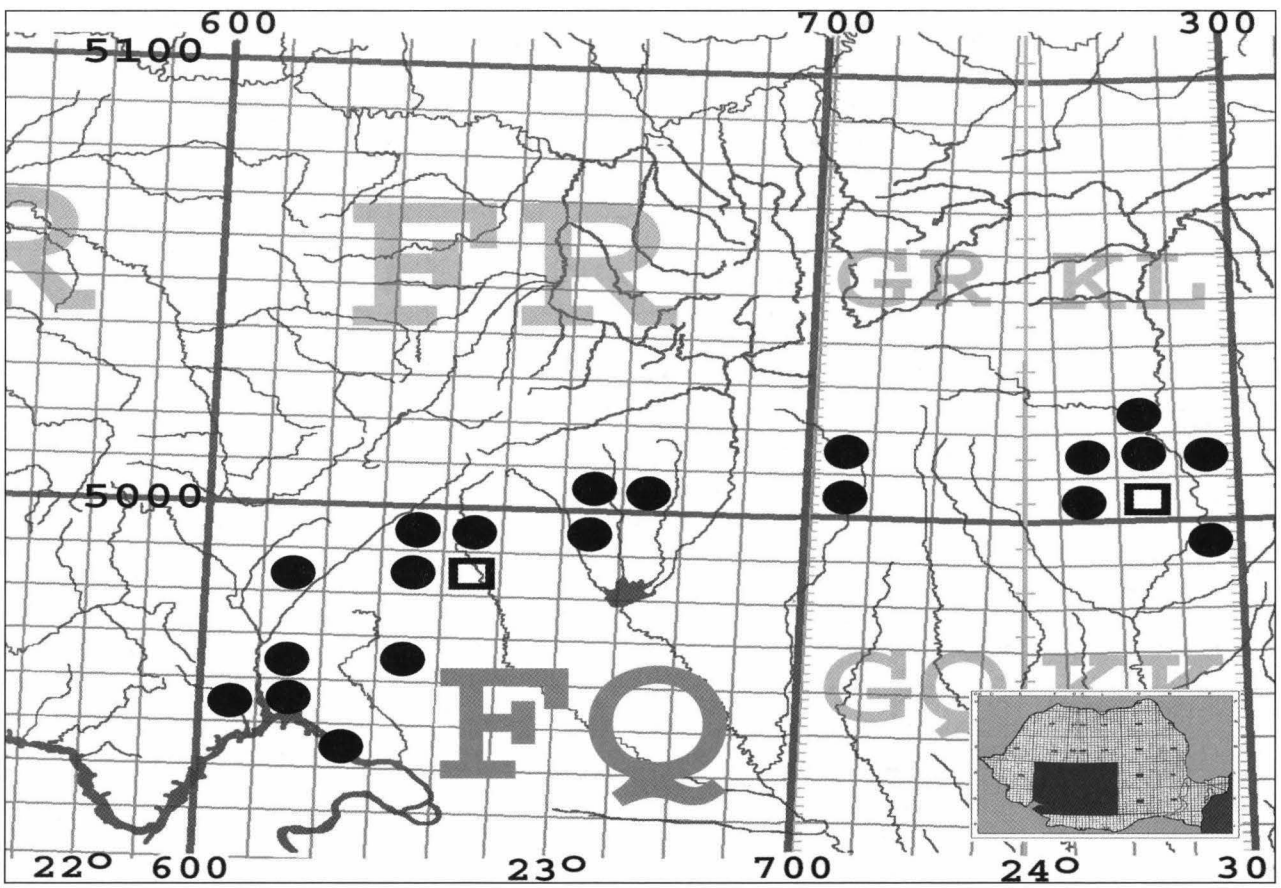


Figure 1. Distribution map in UTM projection system with 100 km quadrants of the sites where plants of *S. telephium* L. were positively found infested *by Aizobius sedi*: Full circles designate sites where we positively confirmed *S. telephium* L. plants infested by *Aizobius sedi* and empty squares designate sites cited after herbarium specimens, where we could not confirm the infestation.

Figura 1. Harta distribuţiei în sistem de proiecţie UTM cu cvadranţi de 100 km ale locurilor unde am găsit plante de *S. telephium* L. infestate cu *Aizobius sedi*: cercurile pline desemnează locuri unde am confirmat infestarea *S. telephium* L. cu *Aizobius sedi* şi pătratele goale desemnează locuri citate după exemplare de herbar, unde nu am confirmat infestarea.

DISCUSSIONS

The infestation range of *S. telephium* by *A. sedi*, in karst habitats of Oltenia, is quite large, and matches well the overall distribution of these habitats. Comparing the distribution of *A. sedi* reported herein by us north of Danube, with the distribution of *S. telephium* in the same region as found by us and as documented by herbarium specimens we can readily notice a good match in occurrence, as practically we have found the insect almost everywhere *S. telephium* was present. The actual range of infestation seems to be limited not by climatic factors but simply by the actual availability of the host plant. This belief is also supported by the fact we have found the insect on *Rhodiola rosea* at higher altitudes in places where *S. telephium* was not available (BÂRCĂ et al., in prep).

It appears and produces (non lethal) lesions (Fig. 2) all over the locations where *S. telephium* was found by us, so the infestation range coincides quite closely with the distribution of the plant.

Both the adults and the preimaginal stages of *A. sedi* are closely associated with relatively few species belonging to the genera *Sedum*, *Rhodiola*, *Sempervivum* of the family of Crassulaceae, which compose its very narrow group of reported host plants. On *S. telephium*, the larvae live as leaf miners and stem borers, feeding on the leaf mesophyll and eventually boring galleries in the midrib of the leaves and sometimes reaching as far deep as the stems.

In Oltenia, the larval stages appear in the leaf by the end of May lasting into July - August, (in June - July according to SCHERF (1964) and make relatively narrow galleries maintaining appreciatively the same diameter or slightly inflating towards the midrib where the older larvae are located. The gallery is not very tortuous and sometimes is branched. The excrements are initially scattered and later more grouped in the chamber in the midrib where the pupation takes place in a small expansion of the gallery containing the loose, ellipsoidal cocoon, visible by transparency when it is located in the midrib. (see also SCHERF, 1964 for more data about the preimaginal stages). According to SCHERF (1964), *A. sedi* also produces mines in *Sedum* - species with terrete and semiterrete leaves, in which cases the insect probably acts mainly as a stem borer.

The adults also feed on the leaves, remaining on the plant as long as the leaves are green and fleshy. The adults feed on the surface of the leaf, making small crateriform lesions 0.9 to 1.8 mm in diameter with sclerified, raised rim of scarification tissue. Usually, the holes do not penetrate the leave, but sometimes they appear as true holes piercing the leaves (Fig. 2). Although the weevil is listed in several red lists throughout Europe, in the region involved in our study there are no indications of serious threats yet. The vulnerability of the insect is though closely related to that of its host plants.

CONCLUSIONS

This study reports findings of both herbarium specimens survey and previously unpublished data from personal fieldwork of the authors. This picture, although still incomplete, will help scholars studying this species to better understand the biological, ecological and chorological features of this taxon. This study will also form the basis of a complete distribution map of *A. sedi* in Romania and will provide arguments for the treatment of *A. sedi* as a (potential) pest for *S. telephium*.

Our preliminary results indicate that indeed the range occupied by *A. sedi* is probably larger than previously believed. We found it in almost all locations where we searched for it, usually in small numbers of few individuals per plant cluster. Therefore, taking into account the relatively wide ecological amplitude of this weevil species, we believe that the actual distribution range of *A. sedi* includes the whole country, and will probably broaden considerably after further research in other locations and also on other hosts will be reported. The lesions inflicted by *A. sedi* to *S. telephium* are not lethal but in the most severe cases, as the larvae developing in leaves and stems do not destroy the shoots infested. The adults may possibly pose a significant threat only when massive attacks occur in dense, intensive cultures.

ACKNOWLEDGEMENT

This paper was partially supported by a grant awarded to author V.B; from the SOP HRD, financed from the European Social Fund and by the Romanian Government under the contract no. POSDRU/6/1.5/S/17".

REFERENCES

BALATRI S. 1981. *L'uso del Sedum telephium L. nella pratica chirurgica minore.* Bollettino della Società Tosco-Umbra di Chirurgia. **42**: 3-8.

BONINA F., PUGLIA C., TOMAINO A., SAIJA A., MULINACCI N. 2000. *In-vitro antioxidant and in-vivo photoprotective effect of three lyophilized extracts of Sedum telephium L. leaves.* Journal Pharmacy-Pharmacology. **52**(10): 1279-85.

BORZA A. FRE no2433b = Flora Romanie Exsiccata, folia no 2433b.

DATTNER A. M. 2004. *Herbal and complementary medicine in dermatology.* Dermatologic Clinics. Edit. Elsevier. **22**: 325-332.

LEHRER A. & LEHRER M. 1990. *Cartografierea faunei şi florei României (coordonate arealografice).* Edit. Ceres, Bucureşti.

LINNE C. 1753. *Species plantarum.* Edit. 1 Uppsala. 430 pp.

MULINACCI N., VINCIERI F., BALDI A., SENDL A., WAGNER H. 1995. *Flavonol glycosides from S. telephium ssp maximum leaves*. Phytochemistry. Edit. Elsevier. **38**: 531-533.

NICULAE MARILENA & BÂRCĂ V. 2005. *Preliminary Data regarding the distribution of the species Sedum hispanicum L (Crassulaceae) in Romanian Southern Carpathians*. Contribuţii. Botanice. Grădina Botanică „Alexandru Borza". Cluj-Napoca. **40**: 35-42.

NICULAE MARILENA & BÂRCĂ V. 2006. *Preliminary Data Regarding The distribution of the species Sedum Annuum L (Crassulaceae)*. In: Romanian Southern Carpathians. Contribuţii Botanice. Grădina Botanică „Alexandru Borza". Cluj-Napoca. **41**(2): 23-32.

PETRI K. 1912. *Siebenbürgens Käferfauna*. Buchdrukerei Jos. Drotleff. Hermannstadt. 342 pp.

RĂVĂRUŢ M. 1953. *Crassulaceae*. In: Săvulescu T. (Ed.) - Flora R.P.R. Edit. Academiei R.P.R. Bucureşti. **4**: 71-72.

SCHERF H. 1964. *Die Entwicklungsstadien der mitteleuropäischen Curculioniden (Morphologie, Bionomie, Ökologie)*. Abhandlungen der senckenbergischen naturforschenden Gesellschaft. **506**: 1-335.

SENDL A., MULINACCI N., WAGNER H. 1993. *Antiinflammatory and immunologically active polysaccharides of Sedum telephium*. Phytochemistry. Edit. Elsevier. **34**: 1357-1362.

***. Fauna Europaea (2007), *Fauna Europaea: Apionidae*. http://www.faunaeur.org. (accessed: March 12, 2011).

Bârcă Valentin
"Carol Davila" University of Medicine and Pharmacy,
Dept. of Biophysics, Bucharest Romania
E-mail: valentinbarca@yahoo.com

Niculae Marilena
University of Bucharest, Plant Biology Dept. Bucharest, Romania
E-mail: mari_niculae@yahoo.com

Received: March 31, 2011
Accepted: August 26, 2011

Figure 2. Aspect of nonperforating lesions produced by *Aizobius sedi* to *Sedum telephium* L. infested "in vivo" – 2A; in herbarium specimens - 2B, and also of perforating lesions together with the weevil – 2C.
Figura 2. Aspectul leziunilor neperforante produse de *Aizobius sedi* pe plantele de *Sedum telephium* L. infestate in „vivo":– 2A; pe exemplare de herbar - 2B şi de leziuni perforante împreună cu gărgăriţa - 2C.

INFESTATION OF THE MEDICINAL/ORNAMENTAL PLANT *Alcea rosea* L. (MALVACEAE) BY THE WEEVIL *Rhopalapion longirostre* OLIVIER, 1807 (COLEOPTERA: CURCULIONOIDEA: APIONIDAE) IN OLTENIA (SOUTHERN ROMANIA)

BÂRCĂ Valentin, NICULAE Marilena, PANAITESCU Dragoş

Abstract. *Alcea rosea* (LINNAEUS, 1758) is an Asian medicinal/ornamental plant introduced in Romania probably by the Turks, centuries ago, now being widely cultivated throughout Romania. Part of a larger study concerning the intensive culture of several medicinal/technical Malvacean species, we have investigated the infestation of *Alcea* sp. by *Rhopalapion longirostre* (OLIVIER 1807), one of the 3 invasive weevils feeding on Malvaceae such as *A. rosea*, often causing considerable damage in leaves and seeds. Although R. longirostre was cited in Europe for the first time from Romania, in 1875, its Romanian range has not been documented until now. We hereby present for the first time for Romania, a list of the locations where *R. longirostre* was found on *A. rosea*, complemented by a grid map in UTM projection system of the species infestation in Oltenia, approximately between 22°30'E – 24°30'E meridians, and the 44° 40'N – 45°40'N parallels; situated approximately between km 4900-5040N of the UTM projection zones 34 and 35. We also present some considerations about the chorology and the ecology of the species with reference to biotic and abiotic factors involved in its distribution and its potential to become a pest of other Malvaceae species of medicinal interest.

Keywords: *Alcea rosea*, *Rhopalapion longirostre*, infestation, Oltenia, Romania.

Rezumat. Infestarea plantei medicinale *Alcea rosea* L. (Malvaceae) de către gărgăriţa *Rhopalapion longirostre* OLIVIER, 1807 (Coleoptera: Curculionoidea: Apionidae) în Oltenia (sudul României). *Alcea rosea* (LINNAEUS, 1758) este o plantă medicinală/ornamentală asiatică introdusă probabil în România de turci cu secole în urmă, acum fiind larg cultivată în toată România. Parte a unui studiu mai larg privind cultura intensivă a unor specii medicinale/tehnice de malvacee, am investigat infestarea plantei *A.rosea* de către curculionidul *Rhopalapion longirostre* (OLIVIER 1807) una dintre cele 3 gărgăriţe care se hrănesc pe malvacee precum *A. rosea* adeseori producând pagube considerabile la seminţe şi frunze. Deşi *R. longirostre* în Europa a fost citata prima dată din România în 1875, aria de răspândire în România nu a fost detaliată până acum. Prezentăm aici în premiera pentru România, o listă a localităţilor în care am găsit *R. longirostre* pe *A. rosea* L., completată de o hartă raster în proiecţie UTM a infestării acestei specii în Oltenia, aproximativ între meridianele 22°30'E - 24°30'E, şi paralelele 44°40'N - 45°40'N: situată cam între km 4900-5040N ai zonelor 34 şi 35 ale sistemului de proiecţie UTM. De asemenea prezentăm unele consideraţii despre corologia şi ecologia speciei referitoare la factorii biotici şi abiotici implicaţi în distribuţia ei şi despre potenţialul ei de a deveni un dăunător la alte specii de malvacee de interes medicinal.

Cuvinte cheie: *Alcea rosea*, *Rhopalapion longirostre*, infestare, Oltenia, România.

INTRODUCTION

As a result of a larger body of work investigating the possibility and opportunity of intensive culture of *A. rosea* in Oltenia, we gathered data about the frequency and range of infestation of this plant by one of its 3 documented invasive apionid herbivores, *Rhopalapion longirostre*.

Alcea rosea is a medicinal/ornamental plant introduced widely in Europe. It originates from temperate Asia and the Ottoman Turks introduced it in Romania probably centuries ago. Being a widely and highly prized ornamental plant, it was repeatedly introduced throughout the country. At present it is distributed ubiquitously throughout the country, mainly cultivated in gardens, but also established around human settlements in the southern part of Romania, where it naturalized in dry, warm, sunny locations, on roadsides. It is characterized by a 1-2.5 meter-long slender, usually unbranched stem. Its flowers grouped in the median part of the inflorescence with indefinite growth represent the part preferred by the weevils to ovoposit.

Rhopalapion longirostre is a monophagous black weevil easily recognisable due to its unusually long rostrum among its European relatives, its grey, thick indumentum and red legs.

It feeds both as adult and preimaginal stages on Malvaceae with sufficiently large seeds, such as *Alcea rosea*, often producing considerable damage in leaves and seeds. The female uses the long rostrum to drill a hole through the two layers of sepals and the petal primordial (Fig. 2B), to reach the ovules where the larva develops. The larvae develop feeding on the monadelphous stamens and then individually on seeds, and pupate inside the mericarpic fruitlets - inside the seeds - emerging after the fruit maturation and dispersal. It is also peculiar among apionids as the adults do not migrate, nor congregate in trees during the unfavourable summer months, but it remain on the host plant hidden between the sepals and the buds, voraciously feeding on the leaves (Figs. 2C; 2D). For more details regarding the biology of *R. longirostre* see DIECKMANN (1977), BEHNE (1998), PUPIER (1997), SPRICK et al. (2002) and WILHELM (2004). Although, according to SAUVARD et al. (2010) t was cited in Europe for the first time in 1875 from Romania, its Romanian range has not been yet documented.

The objective of this paper is to provide a preliminary overall image of the actual distribution of *R. longirostre* in Oltenia.

MATERIAL AND METHODS

Host plant identification:

Due to its probable hybrid origin, the plants found during the survey to resemble *A. rosea* had a large variability, both in terms of morphology and in terms of petal colour. Despite its poorly defined taxonomy, we comprised under the term *A. rosea* all plants that could not be attributed to other *Alcea* species present in Romania (according to MORARIU, 1958), leaving for a later paper the task to ascertain beyond any doubt the assignment of the cited plant specimens or populations to *A. rosea* or to some other related taxa.

Geographical characteristics:

The region involved in our study extends North of Danube being limited to the South approximately by the 44°40'N parallel and the 45°40'N parallel to the North and spanning between 22°30' E meridian to the West and 24°30' E meridian towards East. It comprises the region situated approximately between km 4900-5040N of the UTM projection zones 34 and 35. To establish the UTM geo-codes for the cited locations we have used when applicable Lehrer's work (LEHRER & LEHRER, 1990) or geo-codes derived from GPS coordinate readings from surveys done by the authors. The UTM geo-codes were given when possible for the closest human settlement available.

Because the plant is clearly introduced, the present study did not use altitude or habitat type as a defining criterion for the analysed region, but rather its geographical boundaries.

RESULTS

Our results comprise a number of 27 locations where we found *R. longirostre* on *A. rosea*, all of them newly found by us during the past 20 years (1990-2011). The data are presented below in tabular format (Table 1).

Table 1. List of the locations where we found *Rhopalapion longirostre* on *A. rosea*.
Tabel 1. Lista locaţiilor în care a fost găsită *Rhopalapion longirostre* pe *A. rosea*.

County	Location and Altitude (m. s. m.)	UTM Geo-code	Information Source**
CS	Băile Herculane	FQ16	(B 93)
CS	Pecinisca near Băile Herculane	FQ16	(B 92-01)
CS	Băile Herculane (across from hotel Cerna)	FQ17	(B 95)
CS	The railway station near Băile Herculane	FQ17	(B 93-99) (B&N 03)
CS	The Cerna valley, left side	FQ18	(B 95)
CS	Jidoştiţa	FQ25	(B 93)
CS	Gornenţi	FQ27	(B 93)
GJ	Isverna, close to the entrance to "Isverna cave"	FQ28	(B 10)
GJ	Godeanu	FQ38	(B 95)
GJ	Cerna Sat	FQ39	(B95)
GJ	Cloşani	FQ49	(B 93)
GJ	Motru Sec	FQ49	(B 92)
GJ	Runcu	FQ69	(B 92)
GJ	Cheile Sohodolului/Runcu by the motel	FQ69	(B 92)
GJ	Cheile Oltetului close to peştera Polovragi (Polovragi cave)	GR00	(B 04)
MH	Orşova, near the open market	FQ05	(B 93)
MH	Pecinişca	FQ16	(B 93)
MH	Balta Cerbului	FQ18	(B 93)
MH	Gura Văii	FQ24	(B 93)
VL	Râmnicu Vâlcea	KK99	(B 04, B 09)
VL	Valea Bistriţei close to the monastery	KL60	(B 94)
VL	Valea Cheii, near schitul Iezer	KL70	(B91)
VL	Olăneşti Băi, around the baths	KL80	(B91)
VL	Cozia Monastery and in the vicinity	KL81	(B 01)
VL	Turnu Monastery	KL81	(B 97), (B 02-05), (B 09-10)
VL	Brezoi	KL82	(B 07)
VL	Stânişoara Monastery	KL91	(B 97)

Symbols/Legendă: *The UTM geo-codes were given when possible for the closest human settlement available. / **Codurile UTM** au fost date pentru cele mai apropiate aşezări umane.

County acronyms/prescurtări judeţe: CS = Caraş-Severin, GJ = Gorj, MH = Mehedinti, VL = Vâlcea **collector's name and observation year of *R. longirostre* on *A. rosea* are mentioned. / Sunt menţionate numele colectorului şi anul (sau anii) în care *R. longirostre* a fost observată pe *A. rosea* (BN + XX) = (Bârcă & Niculae + the last 2 digits of the year when the weevil was found on the plant) e.g. (BN 04) = (BÂRCĂ & NICULAE, 2004) (B + XX) = (Bârcă + the last 2 digits of the year when the weevil was found on the plant in situ).

The sites that could be positively located on the map are presented in figure 1, in a convenient format on a map with UTM quadrants and the hydrographic system. For reference, we have provided in the table the years when we have observed the plants in the mentioned sites, as in figure 1.

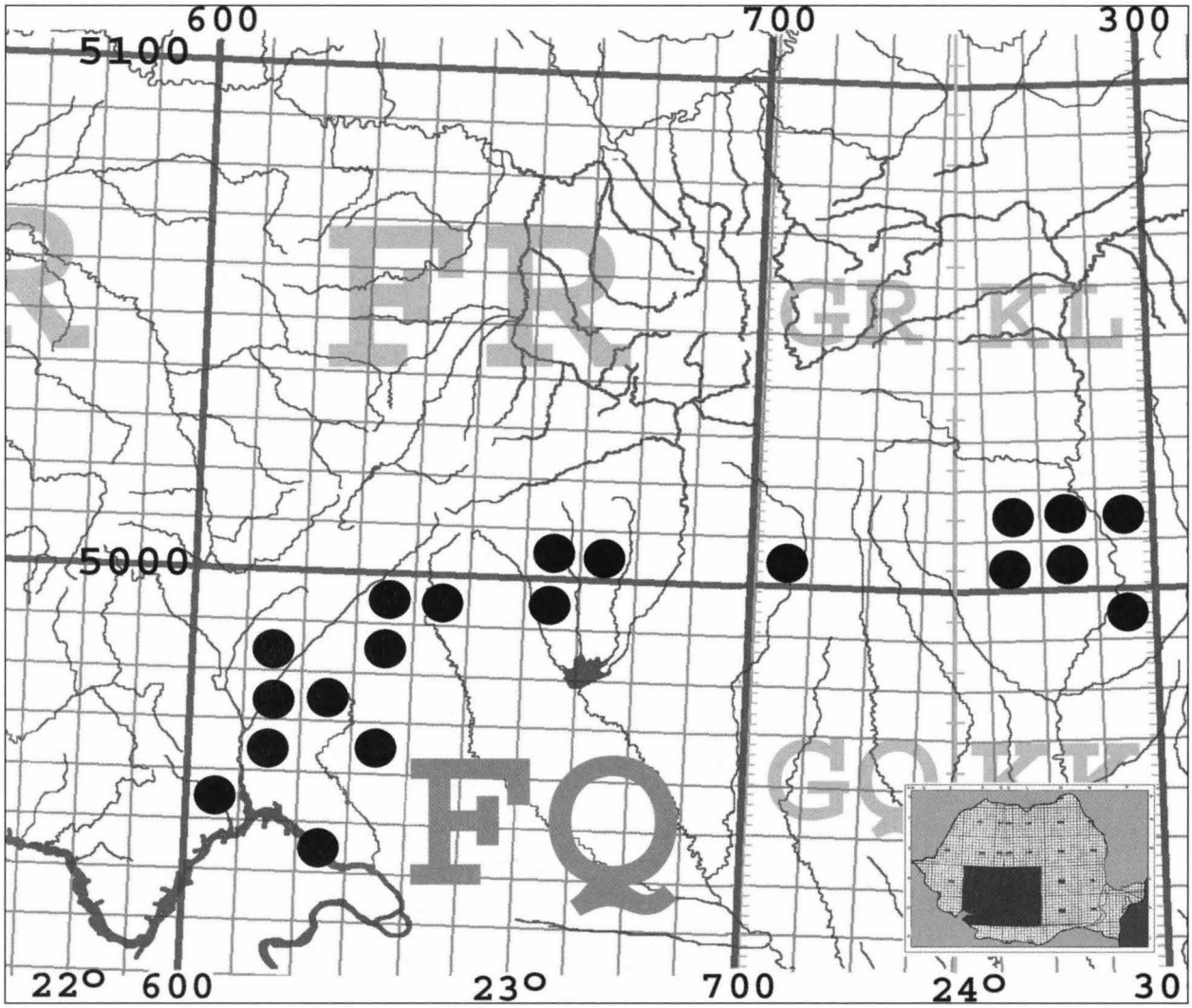


Figure 1. Distribution map in UTM projection system with 100 km quadrants of the sites where *R. longirostre* was found on *A. rosea*; designated by full circles.
Figura 1. Harta distribuţiei în proiecţie UTM cu cvadranţi de 100 km ale locurilor unde au fost găsite plante de *A. rosea* infestate cu *R. longirostre*, desemnate de cercurile pline.

DISCUSSIONS

The infestation range of *A. rosea* by *R. longirostre*, in various habitats in Oltenia, is quite large, and seems to be limited not by climatic factors but simply by the actual availability of the plant. Practically we have found the weevil everywhere we have found the host plant. These findings support the fact that the range of *R. longirostre* closely matches its host plant.

In most locations where *Malva sylvestris* L. plants were available close to infested *A. rosea* we could only find adults, eating the leaves and only few holes drilled in the buds or receptacles/fruits of *Malva sylvestris*, this fostering some experimental work which will result in a later paper.

The aspect of the lesions matches the known ones, and the weevil produces (non lethal) lesions (Fig. 2) anywhere *A. rosea* was cultivated or escaped form cultivation, so the infestation range coincides quite closely with the distribution of the plants.

Both the adults and the preimaginal stages of *A. rosea* are closely associated with *A. rosea* and *M. sylvestris*, belonging to its very narrow group of reported Malvacean host-species.

In Oltenia, the adults appear on plants and produce lesions on the leaf in mid-April lasting until Oct – Nov, probably over wintering buried in the soil by the plants. The adults feed on the leaves, remaining on the plant as long as the weather is warm enough, even after the leaves wilt and the fruits are dry. The adults feed on the surface of the leaf, making small round lesions about 1mm in diameter without sclerified, raised rim of scarification tissue. Usually the holes penetrate the leaves, often merging into much larger holes of irregular shape, similar to the lesions produced by snail (Fig. 2A). The adults are often found on the buds "in copul" as seen in figure 2B.

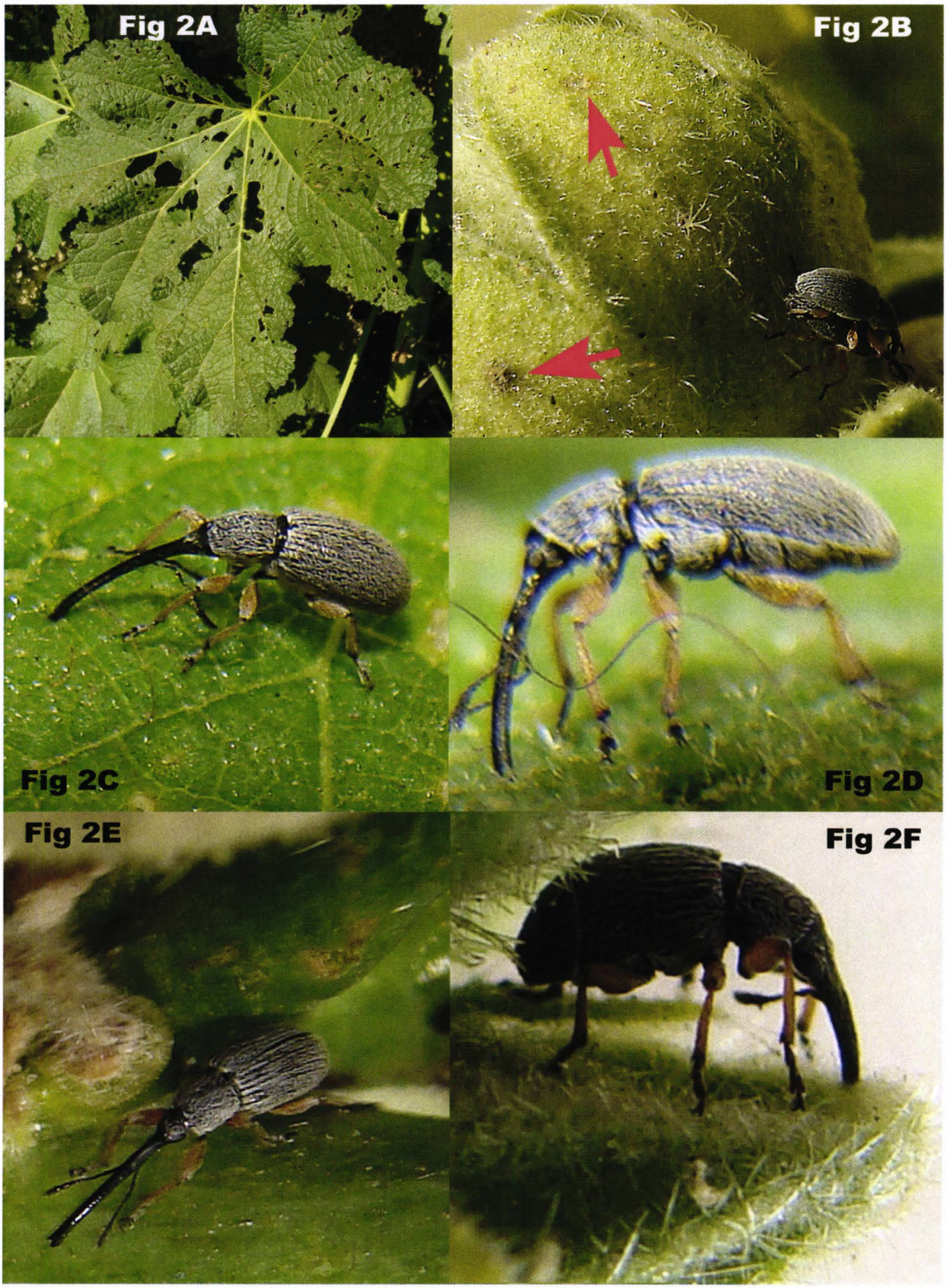


Figure 2. Aspect of the primary and merged perforating lesions resembling those made by snails, inflicted by *R. longirostre* to infested *A. rosea* leaves, "*in vivo*" – 2A; Aspect of oviposition lesions on the buds (red arrows), with the adults "in copula" – 2B; Female *R. longirostre* feeding on leaves – 2C & 2D, and on a stem – 2E; male feeding on a bud – 2F.

Figura 2. Aspectul leziunilor perforante primare (şi confluente semănând celor date de melci) induse de *R. longirostre* pe frunzele de *A. rosea* L. infestate „*in vivo*" - 2A; Aspectul leziunilor la boboci (săgeţi roşii) cu adulţii „în copula"- 2B; Femele hrănindu-se pe frunze – 2C & 2D şi pe o tulpină – 2E; Mascul hrănindu-se pe un boboc – 2F.

CONCLUSIONS

Our preliminary results indicate that indeed the weevil range closely matches its host plant *A. rosea* L. We found it in almost all locations where we searched for it, usually in large to very large numbers of tens of individuals per plant. We expect it to occur in most places where its host plant is available.

The lesions inflicted by *R. longirostre* to *A. rosea* are nonlethal even in the most severely infested plants, as the developing larvae do not destroy all the seed in the capsules infested, and the adults do not manage to destroy the foliage to a significant extent.

The adults may possibly pose a significant threat only when massive attacks occur in dense, intensive cultures of the local plant of medicinal interest *Malva sylvestris*, but its vulnerability to this weevil attack remains to be clarified by further research

Our data, although still incomplete, will help scholars studying this species to better understand some of the biological, ecological, and chorological features of this taxon. This study will also form the basis of a complete distribution map of *R. longirostre* in Romania and will provide data for a study regarding the alleged possibility of transfer of *R. longirostre* from its regular host plant *A. rosea*, to other Malvaceae of medicinal interest native to Romania, especially *Malva sylvestris*, which is a widely distributed native plant that has the potential to naturalize small-bodied *R. longirostre* by establishing large, local overwintering populations of the weevil.

REFERENCES

BEHNE L. 1998. *Familie Apionidae.* In: Lucht W, Klausnitzer B (Eds.). Die Käfer Mitteleuropas, 4. Supplementband. Goecke & Evers Verlag, Krefeld, Jena, Stuttgart, Lübeck, Ulm: 328-331.

DIECKMANN L. 1977. *Beiträge zur Insektenfauna der DDR: Coleoptera – Curculionidae (Apioninae).* Beiträge zur Entomologie. **27**: 7-143.

LEHRER A. & LEHRER M. 1990. *Cartografierea faunei şi florei României (coordonate arealografice).* Edit. Ceres, Bucureşti.

LINNE C. 1753. *Species plantarum.* Ed 1 Uppsala. 687 pp.

MORARIU I. 1958. *Malvaceae.* In: Săvulescu T. (Ed.). Flora R.P.R. Edit. Academiei R.P.R. Bucureşti. **8**: 71-72.

PERRIN H. 1995 *Rhopalapion longirostre (Olivier) (Coleoptera, Apioninae) 12 années de récoltes en France.* L'Entomologiste. Edit. Société entomologique de France. **51**: 67-70.

PUPIER R. 1997. *Quelques observations sur la biologie de Rhopalapion longirostre (OLIVIER) (Coleoptera, Curculionidae, Apioninae).* Bulletin Mensuel de la Société Linnéenne de Lyon. **66**: 45-56.

SAUVARD D., BRANCO MANUELA, LAKATOS F., FACCOLI M., KIRKENDALL L. R. 2010. *Weevils and Bark Beetles (Coleoptera, Curculionoidea).* Chapter 8.2. In: Roques A et al. (Eds.) Alien terrestrial arthropods of Europe. BioRisk. **4**(1): 219–266. doi: 10.3897/biorisk.4.64.

SPRICK P., WINKELMANN H., BEHNE L. 2002. *Rhopalapion longirostre (Olivier, 1807) (Coleoptera, Apionidae): Anmerkungen zur Biologie und zur aktuellen Ausbreitung in Deutschland.* Weevil News, 8: http://www.curci.de/Inhalt.html, Curculio Institut, Mönchengladbach. Accesed: March, 2011.

WILHELM GERTHA, NEMESCHKAL H. L., PLANT J., PAULUS H. F. 2010. *Fitness components in the relationship between Rhopalapion longirostre (Olivier, 1807) (Insecta: Coleoptera: Apionidae) and Alcea rosea (Linnaeus, 1758) (Malvaceae).* Analysis of infestation balance of a herbivorous weevil and its host plant. Bonn zoological Bulletin. Edit. Zoologisches Forschungsmuseum Alexander Koenig. **57**(1): 55-64.

WILHELM GERTHA. 2004. *Die Lebensgeschichte von Rhopalapion longirostre (OLIVIER).* Diploma dissertation, Department of Evolutionary Biology, University of Vienna. 105 pp.

Bârcă Valentin
"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
E-mail: valentinbarca@yahoo.com

Niculae Marilena
AGAVE HI IQ Solutions Bucharest, Romania
E-mail: mari_niculae@yahoo.com

Panaitescu Dragoş
AGAVE HI IQ Solutions Bucharest,
University of Bucharest, Geology Dept. Bucharest, Romania
E-mail: dragospanaitescu@gmail.com

Received: March 23, 2011
Accepted: August 30, 2011

NEW DATA REGARDING THE DIVERSITY OF THE SATYRINAE SUBFAMILY (INSECTA: LEPIDOPTERA: NYMPHALIDAE) FROM THE OLTENIA FAUNA, ROMANIA

CHIMIŞLIU Cornelia

Abstract. This paper updates the state of the knowledge of the Satyrinae diversity and distribution in the Oltenia fauna. The paper synthesizes data from papers published during 1929-2008 regarding the presence of the Satyrinae in the Oltenia fauna and scientifically presents the data held by the specimens of the Satyrinae preserved in the entomological heritage of the Oltenia Museum from Craiova. The analysed specimens were collected during 1951-2010. We have identified 107 collection sites, from which 98 located in the 5 counties of Oltenia. From the 48 species and subspecies of Satyrinae mentioned in the Romanian Fauna, 32 have been identified in the Oltenia fauna. From those, 25 species are preserved in the museum heritage. The obtained data reconfirm the presence and the continuity of these species in the Oltenia fauna and also shows the great diversity of Satyrinae in this area.

Keywords: new data, diversity, Satyrinae, Oltenia, Romania.

Rezumat. Noi date privind diversitatea subfamiliei Satyrinae (Insecta: Lepidoptera: Nymphalidae) în fauna Olteniei, România. Lucrarea actualizează stadiul cunoaşterii diversităţii şi distribuţiei satirinelor în fauna Olteniei. Ea sintetizează date din literatura de specialitate referitoare la prezenţa satirinelor în fauna Olteniei, publicată în perioada 1929-2008 şi valorifică ştiinţific datele deţinute de exemplarele de satirine conservate în patrimoniul Muzeului Olteniei Craiova. Exemplarele analizate au fost colectate în perioada anilor 1951-2010. Au fost identificate 107 situri de colectare, din care 98 situate în cele 5 judeţe ale Olteniei. Din cele 48 de specii şi subspecii de satirine menţionate în fauna României, 32 au fost identificate în fauna Olteniei. Dintre acestea, 25 de specii sunt conservate în patrimoniul muzeului. Datele obţinute reconfirmă prezenţa şi continuitatea prezenţei speciilor în fauna Olteniei şi atestă marea diversitate a satirinelor în această zonă.

Cuvinte cheie: date noi, diversitate, Satyrinae, Oltenia, România.

INTRODUCTION

The paper continues the scientific presentation of the lepidopteran species (Satyrinae subfamily) from the entomological heritage of the Natural Sciences Department of the Oltenia Museum from Craiova.

The main purpose of this paper is to continue the publication of the lepidopteran data in order to enrich the knowledge about the diversity and distribution of the lepidopteran fauna of Oltenia. This paper also completes the data from the last two synthesis papers on the lepidopterans from Romania (RAKOSY et al., 2003; SZÉKELY, 2008), as data regarding the presence of the lepidopterans in the fauna of Oltenia are not mentioned.

The lepidopteran species from the entomological heritage of the museum, published by now are those from:

- the purchased collections: "Mihai Peiu" (CHIMIŞLIU, 1989) and "Ion Firu" (CHIMIŞLIU, 1996, 2006);
- from the donation "Ion Stănoiu" (CHIMIŞLIU & GOGA, 2005).
- the collections made by the museum specialists: species from the Papilionidae family (CHIMIŞLIU, 2008), the Pieridae family (CHIMIŞLIU, 2009), the Sphingidae family (CHIMIŞLIU, 2010), and the Nymphalidae family (pars) (CHIMIŞLIU, 2011).

MATERIAL AND METHODS

The paper is based on data from both papers published during 1929-2008 (MARCU, 1929; KÖNIG, 1953; ALESINSCHI & PEIU, 1954; POPESCU-GORJ, 1955; BOBÎRNAC, 1962; ALESINSCHI & KÖNIG, 1963; BOBÎRNAC & SANDA, 1964; BOBÎRNAC et al., 1966, 1969, 1970, 1971; BOBÎRNAC & STĂNOIU, 1967; STĂNOIU & BOBÎRNAC, 1965; STĂNOIU et al., 1973, 1978; BOBÎRNAC & MATEI, 1983; RAKOSY et al., 2003; CHIMIŞLIU & GOGA, 2005; CHIMIŞLIU, 2006; SZÉKELY, 2008) and on the data preserved in the entomological heritage of the museum.

The analysed specimens came from the collections made by the specialists of the Natural Sciences Department of the Oltenia Museum from Craiova.

The species were determined and revised over the years by I. Firu, Fr. Konig, A. Popescu-Gorj, and Cornelia Chimişliu. For the last determinations and revisions we received the help of Mrs. Dr. Silvia Burnaz and we would like to thank her for this. In order to determine and revise the species, we used the following papers: LAMPERT (1923) POPESCU-GORJ (1955), STĂNOIU et al. (1979), and SZÉKELY (2008).

The nomenclature and the taxonomy of species used in the paper are consistent with the taxonomic system of Fauna Europaea and partially RAKOSY (2007).

For each species we mention: previous reports in literature (in chronological order of the publishing date of the papers, indicating the collecting sites and the collecting years), the analysed material, the number of specimens. The collecting sites are presented in alphabetical order, and the collecting dates in the chronological order of the years and months of collecting. We also mention the protective status under the IUCN and community legislation.

Abbreviations:

- **County names:** BV - Braşov; CS – Caraş Severin; CT – Constanţa; DJ – Dolj; GJ – Gorj; HD – Hunedoara; HR – Harghita; MH – Mehedinţi; OT – Olt; TL – Tulcea; SB – Sibiu; VL – Vâlcea;
- **Protection status** (after SZÉKELY, 2008): EX=Extinct; CR=Critically endangered; EN=Endangered; VU=Vulnerable; NT=Near threatened; LC=Least concern;
- **Legislation:** R.D.B.E.D. = The Red Data Book of European Butterflies (VAN SWAY and WARREN, 1999); HD. 3B, 4B = Fauna-Flora-Habitat Directive (FFH) Annex 3B and Annex 4B;
- **Collectors' name:** B.E. - Bazilescu Elena; C.C. - Chimişliu Cornelia; F.G. - Filcu Gheorghiţa; F.I. - Firu Ion; L.N. - Lila Narcisa; N.A. - Năstase Adrian; P.G. - Păduraru Galina; P.I. - Păunescu Irina; P.M. - Popescu Mircea; V.A. - Vişan Aneta;
- **Other abbreviations:** Mts. = Mountains; Mt. = Mountain; Ms. = Massif; spec. = specimen; specs. = specimens.

RESULTS AND DISCUSSIONS

After processing the material, we have identified 107 collecting sites, of which 98 are located in the 5 counties of Oltenia: Dolj (42), Gorj (30), Vâlcea (17), Mehedinţi (6), and Olt (3), and 9 are from another 7 counties of Romania: BV (2), CS (2), CT (1), HD (1), HR (1), TL (1), and SB (1). Of the 98 sites from Oltenia, 43 are newly identified, 9 have been found again in the consulted literature (Baia de Fier, Bistreţ, Bucovăţ, Cheile Sohodol, Craiova, Işalniţa, Leamna, Polovragi, Rânca), and 46 are sites previously mentioned in literature and not found again in the analysed material from the museum's heritage.

Collecting sites:

1. Baia de Aramă (MH)
2. Baia de Fier (GJ)
3. **Balota** (MH)
4. Balş (OT)
5. Banu Măracine (DJ)
6. Băile Herculane (CS)
7. **Berbeşti** (VL)
8. **Bibeşti** (GJ)
9. Bistreţ (DJ)
10. Borsec (HR)
11. **Branişte** (DJ
12. **Bratovoeşti** (DJ)
13. Bucovăţ (DJ)
14. The Bucovăţ Forest (DJ)
15. Bugiuleşti (VL)
16. **Caraorman** (TL)
17. Călimăneşti (VL)
18. **Căpreni** (GJ)
19. Câlcescu Lake (GJ)
20. **Câmpuşel** (HD)
21. Cernele Forest (DJ)
22. Cireşu (MH)
23. Cârja Peak (Parâng Mts.) (GJ)
24. Cobia Forest (DJ)
25. **Coţofeni** (DJ)
26. **Coţofenii din Faţă** (DJ)
27. Corabia (OT)
28. The Cozia Mountain (VL)
29. Craiova (DJ)
30. **Craiova (Depou)** (DJ)
31. **Craiova (Botanical Garden)** DJ
32. Craiova (Meadow) (DJ)
33. **Craiova (Obedeanu)** (DJ)
34. **Craiova (Park)** (DJ)
35. **Craiova (The Gang Valley)** (DJ)
36. **The Cuşalitru Cave** (GJ)
37. Dăbuleni (DJ)
38. **Desa** (DJ)
39. Dobromira (DJ)
40. Domogled (CS)
41. Drobeta Turnu Severin (MH)
42. Făgăraş (BV)
43. Filiaşi (DJ)
44. The Gilort Valley (GJ)
45. Grădiştea (OT)
46. **Gogoşu** (DJ)
47. Işalniţa (DJ)
48. **The Jiu Meadow** (DJ)
49. Leamna (DJ)
50. **Licurici** (DJ)
51. Lotru Massif (VL)
52. The Lotru Valley (VL)
53. Mamaia (CT)
54. Mândra Peak (Parâng Mts.) (GJ)
55. **Mischii** (DJ)
56. **Mofleni** (DJ)
57. **Negoi** (DJ)
58. Novaci (GJ)
59. Obârşia Lotrului (VL)
60. Ocnele Mari (VL)
61. **Ocniţa** (VL)
62. **Olăneşti** (VL)
63. **The Oltului Valley** (VL)
64. Orşova (MH)
65. The Oslea Peak (GJ)
66. **Oveselu** (VL)
67. The Palilula Forest (DJ)
68. Parâng (chalet) Parâng (surroundings of Parâng chalet) (GJ)
69. The Parâng Mountains (GJ)
70. Parâng Peak (GJ)
71. **Păpuşa Peak** (Parâng Mts.) (GJ)
72. The Păuşa Valley (VL)
73. Perişor (DJ)
74. Perişor Forest (DJ)
75. Piatra Cloşani (GJ)
76. **Pietrele Albe** (GJ)
77. **Pisculeţ** (DJ)
78. **Pleniţa** (DJ)

79. Pociovaliştea (GJ)
80. **Poiana Stampei** (GJ)
81. Poiana Stânei (BV)
82. Polovragi (GJ)
83. **Racoviţa** (VL)
84. **Răcari (DJ)**
85. Rânca (GJ)
86. Rânca (Păpuşa) (GJ)
87. Roaba Forest (DJ)
88. **Rojişte** (DJ)
89. Sadu (SB)
90. **Săcelu** (GJ)
91. **Seaca** (VL)
92. **Secui** (DJ)
93. **Segarcea** (DJ)
94. The Sohodol Gorges (GJ)
95. **Straja-Vâlcan** (GJ)
96. Strehaia (MH)
97. Şimnic (DJ)
98. Tidvele (Parâng) (GJ)
99. **Tismana** (GJ)
100. Tâmbureşti (DJ)
101. Târgu Jiu (GJ)
102. **Târgul Logreşti** (GJ)
103. Turcineşti (GJ)
104. Valea Satului (The Massif Lotru) (VL)
105. **Vâlcan Mountains** (GJ)
106. **Vâlcom** (DJ)
107. Voineasa (VL)

Note: The sites in bold are new; the lowercase ones are old or re-found sites.

Of the 48 species and subspecies mentioned in the fauna of Romania by SZÉKELY (2008), for the subfamily Satyrinae, 32 species were identified in the Oltenia fauna. In the museum heritage it is also preserved a specimen of the form *Melanargia galathea* f. *leucomelas*.

The taxonomic classification of the species is presented in Table 1.

Table 1. The taxonomic distribution of the analysed species in the subfamilies.
Tabel 1. Repartizarea taxonomică a speciilor în cadrul subfamiliilor.

No.	Tribe	No. of genera	No. of species and subspecies	No. of specimens
1.	Coenonymphini	1	4	57
2.	Elymniini	4	5	29
3.	Erebiini	1	10	31
4.	Maniolini	4	5	173
5.	Melanargiini	1	1	60
6.	Satyrini	5	7	29
Total	**6**	**18**	**32**	**379**

The identified species list:

SUBFAMILY SATYRINAE
Tribe Coenonymphini
Genus *Coenonympha* HUBNER 1819

C. arcania (LINNAEUS 1761)

Previous reports from the Oltenia fauna: MARCU, 1929 - Piatra Cloşani (1928); STĂNOIU et al., 1978 – Bucovăţ forest and Cobia forest (1977); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1963).

Examined material - 2 specs.: The Sohodol Gorges 1 spec. July 20, 1999 C.C.; Coţofeni 1 spec. June 26, 1996 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania, except the Danube Delta (SZÉKELY, 2008).

This species was mentioned for the first time in Oltenia by Marcu (1929), with 52 years prior to its mention by RAKOSY et al. (2003).

C. glycerion (BORKHAUSEN 1788)

Previous reports from the Oltenia fauna: STĂNOIU et al., 1978 – The Păuşa Valley (1977); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1964), Ocnele Mari (1964), Baia de Aramă (1967); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU, 2006 - Perişor (1976).

Examined material - 12 specs.: Bucovăţ 1 spec. July 25, 1979 P.I.; 2 specs. August 3, 1981 C.C.; Negoi 5 specs. August 3, 1998 V.A.; Răcari 4 specs. July 27, 1998 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania except the Danube Delta (SZÉKELY, 2008).

The first specimens preserved in the museum heritage are from 1961, 17 years prior to those mentioned by RAKOSY et al. (2003).

C. leander (ESPER 1784)

Previous reports from the Oltenia fauna: RAKOSY et al., 2003 (Oltenia 1901-1980).

Examined material - 2 specs.: The Sohodol Gorges June 28, 2000 C.C.

Protection status: EN (SZÉKELY, 2008).

Distribution: Southern Banat (SZÉKELY, 2008).

The species was mentioned by RAKOSY et al. (2003) for the period 1981-2001. Our data confirm also the presence of these species in the Northern Oltenia after 1980.

C. pamphilus (LINNAEUS 1758)

Previous reports from the Oltenia fauna: ALEXINSCHI & PEIU, 1954 - Roaba Forest; ALESINSCHI & KONIG, 1963 - The Parâng Mountains (1952); STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); BOBÎRNAC et al., 1970 - Craiova (1957); STĂNOIU et al., 1978 - Sadu (1976); BOBÎRNAC & MATEI, 1983 - Tâmbureşti and Banu Măracine (1976-1982); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Balş (1968), Călimăneşti (1963), Corabia (1970), Craiova (1963, 1964), Filiaşi (1962); CHIMIŞLIU, 2006 - Bugiuleşti (1964), Craiova (1964), Novaci (1963), Turcineşti (1968).

Examined material - 41 specs.: Baia de Fier 2 specs. May 23, 1951 I.F.; 2 specs. May 11, 1958 I.F.; Bistreţ 1 spec. June 2, 1982 C.C.; Bucovăţ 1 spec. May 23, 1983 N.A.; 1 spec. June 12, 1983 V.A.; 1 spec. August 12, 1983 V.A.; 1 spec. July 3, 1997 F.G.; Căpreni 2 specs. June 13, 1967 B.E.; 1 spec. June 16, 1967 B.E.; The Sohodol Gorges 3 specs. July 21, 1995 C.C.; 1 spec. July 26, 1996 C.C.; 1 spec. July 16, 1999 C.C.; Coţofenii din Faţă 4 specs. May 26, 1996 C.C.; 1 spec. May 18, 1997 C.C.; Craiova (Depot) 2 specs. May 23, 1983 N.A.; Craiova (Meadow) 1 spec. August 13, 1966 P.M.; Craiova (Gang Valley) 1 spec. May 1, 1983 N.A.; Desa 2 specs. July 25, 1989 C.C.; Mamaia 1 spec. July 16, 1991 C.C.; Mofleni 2 specs. August 22, 1968 B.E.; Ocniţa 1 spec. August 15, 1998 C.C.; Oveselu 2 specs. October 5, 1966 B.E.; Pleniţa 1 spec. July 1, 1984 C.C.; Răcari 1 spec. May 18, 1996 C.C.; Rânca 1 spec. August 4, 1987 leg. C.C.; Secui 2 specs. June 10, 2010.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania, (SZÉKELY, 2008).

The species was mentioned by RAKOSY et al. (2003) for the period 1981-2001, even though the first mention of the species was made by ALEXINSCHI & PEIU (1954). Our data certify the presence of this species in Oltenia starting from 1951 until 2010.

Tribe Elymniini

Genus *Kirinia* MOORE 1893

K. roxelana (CRAMER 1777)

Previous reports from the Oltenia fauna: KÖNIG, 1953 - Orşova (1936); RAKOSY et al., 2003 (Oltenia 1901-1980), CHIMIŞLIU & GOGA, 2005 - Ocnele Mari (1964, 1973).

Protection status: EN (SZÉKELY, 2008).

Protected species: R.D.B.E.B., HD. 3B, 4B (SZÉKELY, 2008).

Distribution: The South of Banat and Oltenia, Dobrogea (SZÉKELY, 2008).

The species was not found in the analysed material.

Genus *Lasiommata* WESTWOOD 1841

L. maera (LINNAEUS 1758)

Previous reports from the Oltenia fauna: STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); STĂNOIU et al., 1978 - Sadu (1977) and Leamna (1976); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Craiova (1964).

Examined material - 6 specs.: Bucovăţ 1 spec. June 03, 1981 C.C.; Coţofeni 1 spec. May 18, 1997 C.C.; Işalniţa 1 spec. May 26, 1999 C.C.; Leamna 1 spec. May 16, 1969 P.M.; Pietrele Albe 1 spec. August 3, 1996 P.A.; Răcari 1 spec. July 27, 1998 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania (SZÉKELY, 2008).

RAKOSY et al. (2003) mention the presence of the species in Oltenia between 1981and 2001, but it was collected in 1957 (STĂNOIOU & BOBÎRNAC, 1965) and has been present in the museum heritage since 1969.

L. megera (LINNAEUS 1767)

Previous reports from the Oltenia fauna: ALESINSCHI & PEIU (1954) - Roaba Forest (1952); STĂNOIU & BOBÎRNAC, 1965 - Pociovalişţea (1957); BOBÎRNAC et al., 1966 - Cireşu (1964); STĂNOIU et al., 1973 - Grădiştea (VL); STĂNOIU et al., 1978 - Sadu (1976); RAKOSY et al., 2003 (Oltenia 1981-2001); CHIMIŞLIU & GOGA, 2005 - Craiova (1964), Poiana Stânei (1966), Işalniţa (1967); CHIMIŞLIU, 2006 - Bugiuleşti (1964), Craiova (1964, 1965), Novaci (1963).

Examined material - 9 specs.: Bibeşti 1 spec. July 7, 1977 B.E.; Bratovoeşti 1 spec. June 17, 2008 B.L.; Bucovăţ 1 spec. June 19, 1968 P.I.; Craiova 1 spec. August 5, 1951 F.I.; Craiova (Park) 1 spec. May 20, 1982 V.A.; Mamaia 2 specs. August 15, 1991 C.C.; Mofleni 1 spec. June 17, 1968 P.M.; Rânca 1 spec. July 23, 1982 V.A.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania, except Dobrogea (SZÉKELY, 2008).

RAKOSY et al. (2003) mention the presence of this species in Oltenia between 1981 and 2001, but it was previously mentioned in 1954 (ALESINSCHI & PEIU, 1954). Our data show the existence of this species in Oltenia also after the period mentioned by RAKOSY et al. (2003), the last collection being made in 2008.

Genus *Pararge* HUBNER 1819

P. aegeria LINNAEUS 1758

Previous reports from the Oltenia fauna: ALESINSCHI & PEIU (1954) - Roaba Forest; ALESINSCHI & KONIG (1963) – Valea Satului (1951) and Cireşu (1951); STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); STĂNOIU et al., 1978 - common throughout Oltenia (1977); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005) - Craiova (1963); CHIMIŞLIU, 2006 - Bugiuleşti (1964).

Examined material - 14 specs.: Bucovăţ 2 specs. June 15, 1968 P.I.; 1 spec. June 3, 1991 C.C.; The Sohodol Gorges 3 specs. August 5, 1992 C.C.; 1 spec. July 29, 1995 C.C.; 1 spec. August 5, 1996 C.C.; 1 spec. July 16, 1999 C.C.; Craiova 1 spec. July 13, 1970 P.I.; Craiova (Botanical Garden) 1 spec. June 20, 2005 B.L.; Pietrele Albe 1 spec. August 3, 1996 P.A.; Polovragi 1 spec. August 12, 1971 B.E.; Tismana 1 spec. August 23, 1992 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania except the Danube Delta (SZÉKELY, 2008).

RAKOSY et al. (2003) mention the presence of this species in Oltenia between 1981and 2001, but it was previously mentioned in 1954 (ALESINSCHI & PEIU, 1954). Our data show the existence of this species in Oltenia also after the period mentioned by RAKOSY et al. (2003), the last collection being made in 2005.

Genus *Lopinga* MOORE 1893

L. achine (SCOPOLI 1763)

Previous reports from the Oltenia fauna: STĂNOIU & BOBÎRNAC, 1965 - The Gilort Valley (1957); STĂNOIU et al., 1978 - Târgu Jiu (1976); RAKOSY et al., 2003 - Oltenia (1901-1980).

Protection status: VU (SZÉKELY, 2008).

Distribution: Northern Oltenia, Northern Moldova, Northern Banat, Crişana, Transylvania, Satu Mare, Muntenia (SZÉKELY, 2008). The species misses from the museum heritage.

Tribe Erebiini

Genus *Erebia* DALMAN 1816

E. aethiops (ESPER 1777)

Previous reports from the Oltenia fauna: MARCU, 1929 - Oslea Peak, Piatra Cloşani (1928); POPESCU-GORJ, 1955 - Parâng Peak (1952), Valea Satului (1952), Voineasa (1952); ALESINSCHI & KÖNIG (1963) - Lotru Massif (1952); RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1966, 1969).

Examined material 14 - specs.: Borsec 1 spec. August 6, 1958 F.I.; Câmpuşel 1 spec. July 27, 1982 P.I.; The Sohodol Gorges 1 spec. July 23, 1982 P.I.; 1 spec. July 16, 1999 C.C.; 1 spec. August 11, 2004 L.N.; Craiova 2 specs. August 3, 1958 P.I.; Vâlcan Mountains 5 specs. August 9, 1991 V.A.; 2 specs. July 30, 1980 N.A.

Protection status: LC (SZÉKELY, 2008).

Distribution: Northern Oltenia, Transylvania, Maramureş, Southern Banat, Western Moldova (SZÉKELY, 2008).

RAKOSY et al. (2003) mention the presence of this species in Oltenia between 1981and 2001, in the consulted literature, the first mention of this species dates from 1928 (MARCU, 1929). Our data show the existence of this species in Oltenia also after the period mentioned by RAKOSY et al. (2003), the last collection being made in 2004.

E. epiphron transsylvanica (REBEL 1908)

Previous reports from the Oltenia fauna: ALESINSCHI & KÖNIG (1963) - Câlcescu Lake, Mândra Peak, Cârja and Parâng, Obârşia Lotrului (1952); BOBÎRNAC et al., 1971 - Rânca (1964); RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1963).

Examined material - 9 specs.: Rânca 3 specs. August 4, 1980 C.C.; 4 specs. July 21, 1982 C.C.; 1 spec. Rânca (Păpuşa) 1 spec. August 12, 1960 B.E.; Tismana 1 spec. July 5, 1962 P.I.

Protection status: NT (SZÉKELY, 2008).

Distribution: The Eastern and Southern Carpathians, the east side (SZÉKELY, 2008).

SZÉKELY (2008) mentions the spreading of the species in the east of the Southern Carpathians. Our data also show the presence of the species in the Southern side of the Southern Carpathians.

E. euryale syrmia (FRUHSTOFER 1919)

Previous reports from the Oltenia fauna: ALESINSCHI & KÖNIG (1963) - Parâng and Obârşia Lotrului (1952); BOBÎRNAC et al., 1971 - Rânca (1964); RAKOSY et al., 2003 - Oltenia (1981-2001).

Protection status: NT (SZÉKELY, 2008).

Distribution: The Eastern and Southern Carpathians, The Apuseni Mountains (SZÉKELY, 2008).

The species misses from the museum heritage.

E. gorge fridericiokoenigi VARGA 1999

Previous reports from the Oltenia fauna: ALESINSCHI & KÖNIG (1963) - Cârja Peak (Parâng), Câlcescu Lake (1954); RAKOSY et al., 2003 - Oltenia (1901-1980).

Examined material 1 spec.: Rânca July 21, 1982 C.C.
Protection status: VU (SZÉKELY, 2008).
Distribution: The Eastern and Southern Carpathians, The Apuseni Mountains (SZÉKELY, 2008).

E. ligea nikostrate FRUSHSTORFER 1909
Previous reports from the Oltenia fauna: BOBÎRNAC et al., 1971 - Parâng chalet (1963); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Domogled (1966), Rânca (1964).
Examined material - 4 specs.: The Sohodol Gorges 1 spec. July 16, 1999 C.C.; 2 specs. June 28, 2000 C.C.; Rânca 1 spec. July 23, 1982 V.A.
Protection status: LC (SZÉKELY, 2008).
Distribution: The Eastern and Southern Carpathians and the Apuseni Mountains, Southern Banat and Northern Oltenia (SZÉKELY, 2008).
RAKOSY et al. (2003) mention the presence of this species in Oltenia between 1981and 2001, but the first mention of this species dates from 1963 (BOBÎRNAC et al., 1971).

E. manto trajanus HORMUZACHI 1895
Previous reports from the Oltenia fauna: RAKOSY et al., 2003 - Oltenia (1901-1980).
Protection status: VU (SZÉKELY, 2008).
Distribution: The Eastern and Southern Carpathians (SZÉKELY, 2008).
The species from the museum heritage.

E. medusa medusa (DENIS & SCHIFFERMÜLLER 1775)
Previous reports from the Oltenia fauna: BOBÎRNAC, 1962 - Tidvele Mountain (Parâng) (1957); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1964); CHIMIŞLIU, 2006 - Rânca (1962).
Examined material - 1 spec.: Seaca May 18, 1972 B.E.
Protection status: LC (SZÉKELY, 2008).
Distribution: Northern Oltenia, Transylvania, Maramureş, Crişana, Satu Mare, Western Moldova (SZÉKELY, 2008).
The first mention of this species in Oltenia dates since 1962 (BOBÎRNAC, 1962), but the species was collected in 1957. RAKOSY et al., 2003 mentions the species in Oltenia between 1981and 2001.

E. melas melas (HERBST 1796)
Previous reports from the Oltenia fauna: MARCU, 1929 - Turnu Severin (1928); RAKOSY et al., 2003 - Oltenia (1850-1900).
Examined material - 1 spec.: The Sohodol Gorges August 30, 1974 P.I.
Protection status: VU (SZÉKELY, 2008).
Distribution: The western side of the Southern Carpathians and the southern Banat (SZÉKELY, 2008).
RAKOSY et al. (2003) mention the presence of this species in Oltenia until 1928. It was found again by Marcu in 1928 at Drobeta Turnu Severin (MARCU, 1929). The continuing existence of this species is confirmed by data from the museum heritage until 1974.

E. pandrose roberti (PESCHKE 1920)
Previous reports from the Oltenia fauna: BOBÎRNAC, 1962 - Păpuşa Peak (1957); RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Rânca (1970), Parâng Peak (1964).
Examined material - 1 spec.: Rânca July 12, 1982 C.C.
Protection status: NT (SZÉKELY, 2008).
Distribution: The Southern Carpathians and the northern side of the Eastern Carpathians (SZÉKELY, 2008).

E. sudetica radnaensis REBEL **1915**
Previous reports from the Oltenia fauna: RAKOSY et al., 2003 - Oltenia (1981-2001).
Protection status: EN (SZÉKELY, 2008).
Distribution: The Southern and Eastern Carpathians (SZÉKELY, 2008).
This subspecies misses from the museum heritage.

Tribe Maniolini

Genus *Aphantopus* WALLENGREN 1853

A. hyperantus (LINNAEUS 1758)
Previous reports from the Oltenia fauna: STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); STĂNOIU et al., 1978 - Sadu (1976); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1964), Craiova (1962).

Examined material - 19 specs.: Baia de Fier 2 specs. May 11, 1958 P.G.; 1 spec. Bucovăţ June 3, 1958 P.G.; 1 spec. June 8, 1958 P.G.; The Sohodol Gorges 1 spec. July 21, 1999 C.C.; 1 spec. July 24, 1999 C. C.; 1 spec. August 11, 2004 C.C.; Craiova 2 specs. July 14, 1959 B.E.; Licurici 1 spec. July 2, 1982 P.I.; Olăneşti 1 spec. July 8, 1957 P.G.; Oveselu 1 spec. October 5, 1966 B.E.; The Cuşalitru Cave 1 spec. July 31, 1966 B.E.; Racoviţa 2 specs. July 20, 1984 C.C.; Rojişte 3 specs. July 25, 1984; P.I.; Tismana 1 spec. July 7, 1966 B.E.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania except the Danube Delta (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1981and 2001, but it was previously reported (STĂNOIOU & BOBÎRNAC, 1965), being collected in 1957. Our data confirm the existence of this species in Oltenia during 1958-2004.

Genus *Hyponephele* MUSCHAMP 1915

H. lycaon (ROTTEMBURG 1775)

Previous reports from the Oltenia fauna: STĂNOIU & BOBIRNAC, 1965 - Pociovalişte (1957); RAKOSY et al., 2003 - Oltenia (1981-2001).

Protection status: VU (SZÉKELY, 2008).

Distribution: The Southern and Eastern Carpathians, the Apuseni Mountains, Southern Banat and Southern Moldova (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1981and 2001, but it was previously reported (STĂNOIOU & BOBÎRNAC, 1965), being collected in 1957. The species misses from the museum heritage.

Hyponephele lupinus (O. COSTA 1836)

Previous reports from the Oltenia fauna: RAKOSY et al., 2003 - Oltenia (1901-1980); Southern Oltenia (SZÉKELY, 2008) as uncertain area.

Protection status: CR (SZÉKELY, 2008).

Distribution: The Danube Delta (SZÉKELY, 2008). The species misses from the museum heritage.

Genus *Maniola* SCHRANK 1801

M. jurtina jurtina (LINNAEUS 1758)

Previous reports from the Oltenia fauna: MARCU, 1929 - Piatra Cloşani (1928); ALEXINSCHI & PEIU (1954) - Roaba Forest (1952); ALESINSCHI & KONIG (1963) Lotru Mountains; BOBÎRNAC & SANDA, 1964 - Tâmbureşti and Dăbuleni (1959); STĂNOIU & BOBÎRNAC, 1965 - Polovragi (1957); STĂNOIU et al., 1973 - Grădiştea (1972); STĂNOIU et al., 1978 - Leamna (1977); RAKOSY et al., 2003 (Oltenia 1981-2001); CHIMIŞLIU & GOGA, 2005 - Ocnele Mari (1964); Bugiuleşti (1964, 1965), Craiova (1964), Dobromira (1975), Făgăraş (1968), Leamna (1963), Tismana (1976), Turcineşti (1968,1976).

Examined material - 148 specs.: Baia de Fier 1 spec. May 11, 1958 F.I.; 1 spec. May 23, 1958 P.G.; 1 spec. July 9, 1958 B.E.; Berbeşti 2 specs. September 28, 1971 B.E.; Braniste 1 spec. June 29, 1982 P.I.; Bucovăţ 4 specs. June 3, 1958 P.G.; 1 spec. June 6, 1958 P.G.; 1 spec. July 27, 1967 P.M.; 1 spec. July 21, 1967 M.P.; 1 spec. July 3, 1997 F.G.; 1 spec. June 23, 1998 F.G.; 2 specs. July 23, 1998 V.A.; 3 specs; July 29, 2001 V.A.; 1 spec. July 5, 2003 F.G.; 1 spec. July 5, 2005 C.C. and B.L.; Caraorman 1 spec. June 26, 1989 C.C.; The Sohodol Gorges 1 spec. July 23, 1982 P.I.; 1 spec. August 5, 1992 C.C.; 1 spec. July 20, 1995 C.C.; 1 spec. July 27, 1995 C.C.; 5 specs. July 26, 1996 C.C.; 9 specs. August 5, 1996 C.C.; 4 specs. July 24, 1999 C.C.; 1 spec. June 26, 2000 C.C.; 1 spec. June 28, 2000 V.A.; 1 spec. August 5, 2004 C.C.; Craiova 1 spec. August 1, 1958 P.G.; 1 spec. June 17, 1969 B.E.; 4 specs. June 26, 1991 V.A.; Craiova (Botanical Garden) 2 specs. July 28, 1989 V.A.; Craiova (Meadow) 3 specs. July 13, 1970 P.I.; Craiova (Obedeanu) 3 specs. July 24, 1973 F.I.; Craiova (Park) 1 spec. May 27, 1981 V.A.; Desa 1 spec. August 5, 1982 C.C.; 3 specs. July 25, 1989 C.C.; Leamna 1 spec. July 5, 1965 B.E.; 1 spec. July 8, 1966 F.I.; Licurici 1 spec. July 2, 1982 P.I.; The Jiu Meadow 1 spec. June 15, 1958 P.G.; 1 spec. August 13, 1966 P.M.; 1 spec. September 24, 1966 P.I.; 1 spec. June 17, 1968 P.I.; Mamaia 4 specs. July 16, 1991 C.C.; Mischii 1 spec. June 19, 1992 F.G.; Mofleni 2 specs. June 15, 1958 P.G.; 1 spec. June 19, 1958 P.G.; 1 spec. June 17, 1958 P.M.; Negoi 2 specs. August 3, 1998 V.A.; Ocniţa 3 specs. August 15, 1998 C.C.; Olăneşti 3 specs. July 8, 1957 P.G.; 1 spec. June 7, 1958 P.G.; Oveselu 1 spec. october 5, 1966 B.E.; The Cuşalitru Cave 1 spec. July 31, 1966 B.E.; Pietrele Albe 1 spec. August 3, 1996 P.A.; Pisculeţ 1 spec. August 31, 1998 C.C.; Racoviţa 7 specs. July 10, 1979 N.A.; 11 specs. July 20, 1984 C.C.; Rojişte 2 specs. July 25, 1989 P.I.; Secui 1 spec. May 27, 2008 C.C.; 1 spec. July 20, 2010 C.C.; Segarcea 6 specs. June 20, 1981 C.C.; 1 spec. June 21, 1981 N.A.; 1 spec. June 17, 1982 V.A.; Şimnic 1 spec. July 7, 2001 F.G.; Tismana 1 spec. June 24, 1970 B.E.; 2 specs. June 25, 1970 B.E.; 1 spec. August 23, 1992 C.C.; 1 spec. August 25, 1992 C.C.; The Lotru Valley 1 spec. August 24, 1957 F.I.; The Olt Valley 11 specs. August 4, 1979 N.A.; Vâlcom 4 specs. June 20, 1990 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1981 and 2001, but it was previously reported by MARCU (1929) - Piatra Cloşani. Our data confirm the existence of this species in Oltenia during 1957-2010.

Genus *Pyronia* HUBNER 1819

P. tithonus tithonus (LINNAEUS 1767)

Previous reports from the Oltenia fauna: STĂNOIU et al., 1973 - Grădiştea; RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Domogled (1966), Băile Herculane, Călimăneşti (1966).

Examined material - 16 specs.: Balota 1 spec. July 21, 1973 B.E.; The Sohodol Gorges 1 spec. July 26, 1996 C.C.; Craiova 1 spec. June 23, 1958 P.G.; Peştera Cuşalitru 1 spec. July 31, 1966 B.E.; Polovragi 9 specs. August 12, 1971 B.E.; Tismana 3 specs. August 23, 1992 C.C.

Protection status: EN (SZÉKELY, 2008).

Distribution: Banat, South-west Transylvania, Crişana, Satu Mare (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1900 and1980. Our data confirm the existence of this species in Oltenia during 1958-1996.

Tribe Melanargiini

Genus *Melanargia* MEIGEN 1828

M. galathea (LINNAEUS 1758) (Fig. 1).

Previous reports from the Oltenia fauna: MARCU 1929 - Piatra Cloşani (1928); ALEXINSCHI & PEIU (1954) - Roaba Forest (1952); ALESINSCHI & KONIG (1963) - The Parâng Mountains; STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); BOBÎRNAC et al., 1966 - Cireşu (1964); BOBÎRNAC et al., 1970 - Novaci (1957); STĂNOIU et al., 1978 - Leamna (1977); BOBÎRNAC & MATEI, 1983 - Tâmbureşti and Banu Măracine (1976-1982; RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1963); CHIMIŞLIU, 2006 - Craiova (1970), Făgăraş (1965), Plenita (1973), Turcineşti (1968).

Examined material - 59 specs.: Bucovăţ 1 spec. July 21, 1980 C.C.; 1 spec. July 4, 1982 V.A.; 7 specs. July 23, 1998 V.A.; The Sohodol Gorges 1 spec. July 21, 1999 C.C.; 1 spec. July 20, 2001 A.V.; 2 specs. July 5, 2005 C.C. şi B.L.; Plenita 2 specs. July 9, 1984 C.C.; Poiana Stampei 1 spec. July 26, 1953 F.I.; Racovita 1 spec. July 10, 1979 N.A.; 6 specs. July 20, 1984 C.C.; Săcelu 2 specs. July 5, 1980 N.A.; Segarcea 1 spec. June 20, 1981 C.C.; 6 specs. June 10, 2002 C.C.; Straja-Vâlcan 1 spec. August 9, 1991 V.A.; Târgul Logreşti 3 specs. July 9, 1975 B.E.; The Olt Valley 23 specs. July 31, 1979 N.A.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1981and 2001, but it was previously reported by MARCU (1929) - Piatra Cloşani. Our data confirm the existence of this species in Oltenia during 1953-2005.

M. galathea (LINNAEUS 1758) (f. *leucomelas*) (Fig. 2).

Examined material: Bucovăţ 1 spec. July 5, 2005 C.C.

This is the first mentioned in the fauna of Oltenia.

Figure 1. *Melanargia galathea* (ventral part) (original).
Figura 1. *M. galathea* (partea ventrală) (original).

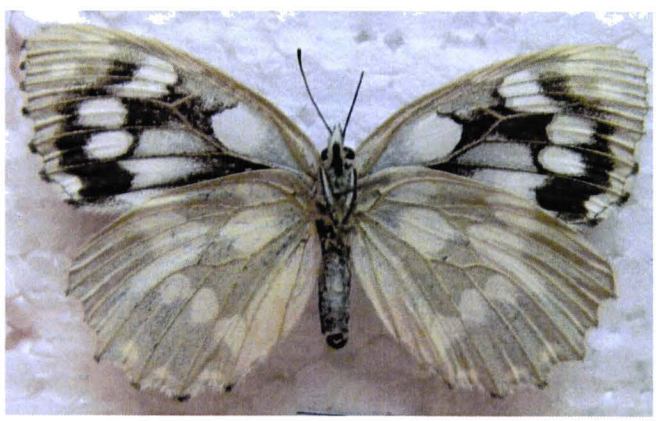


Figure 2. *M. galathea* f. *leucomelas* (ventral part) (original).
Figura 2. *M. galathea* f. *leucomelas* (partea ventrală) (original).

Tribe Satyrini

Genus *Arethusana* LESSE 1951

A. arethusa arethusa (DENIS & SCHIFFERMULLER 1775)

Previous reports from the Oltenia fauna: (1953)-Orşova-Alion Hill; RAKOSY et al., 2003 (Oltenia 190-1980).

Protection status: EN (SZÉKELY, 2008).

Distribution: Banat, South-west Transylvania, Dobrogea (SZÉKELY, 2008).

The species misses from the museum heritage.

Genus *Hipparchia* FABRICIUS 1807

H. (Hipparchia) fagi (SCOPOLI 1763)

Previous reports from the Oltenia fauna: STĂNOIU et al., 1978 - Sadu (1976); RAKOSY et al., 2003 - Oltenia (1901-1980).

Examined material - 3 specs.: The Sohodol Gorges 1 spec. July 19, 1999 C.C.; 1 spec. August 15, 2003 C.C.; Gogoşu 1 spec. August 10, 2001 N.A.

Protection status: LC (SZÉKELY, 2008).

Distribution: The Northern Oltenia, Muntenia, Banat, Transylvania, Crişana, Northern Dobrogea (SZÉKELY, 2008).

RAKOSY et al. (2003) mentions the presence of the species in Oltenia between 1981and 2001. Our data confirm the continuing existence of this species in Oltenia during 1958-2004.

H. semele semele (LINNAEUS 1758)

Previous reports from the Oltenia fauna: STĂNOIU et al., 1978 – Orşova (1976); RAKOSY et al., 2003 - Oltenia (1981-2001); CHIMIŞLIU & GOGA, 2005 - Călimăneşti (1964).

Examined material - 5 specs.: The Sohodol Gorges 1 spec. June 23, 1982 P.I.; 1 spec. July 19, 1999 C.C.; 1 spec. July 24, 1999 C.C.; 1 spec. July 22, 1995 C.C.; 1 spec. May 5, 1996 C.C.

Protection status: LC (SZÉKELY, 2008).

Distribution: Northern Muntenia, Banat, Transylvania, Crişana, Satu Mare, Dobrogea (SZÉKELY, 2008).

This species was not mention by de SZÉKELY (2008) in Oltenia.

H. statilinus (HUFNAGEL 1766)

Previous reports from the Oltenia fauna: STĂNOIU et al., 1978 - Strehaia (1975); RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Băile Herculane (1966), Drobeta Turnu-Severin (1963), Orşova (1968).

Protection status: VU (SZÉKELY, 2008).

Distribution: Southern Banat, South-west Oltenia, Dobrogea, South-west Muntenia, The Danube Delta (SZÉKELY, 2008).

The species has been present in the museum heritage since 1963, 18 years prior to the date mentioned by RAKOSY et al. (2003).

The species was not found again in the analysed material.

Genus *Chazara* MOORE 1893

C. briseis briseis (LINNAEUS 1764)

Previous reports from the Oltenia fauna: CHIMIŞLIU & GOGA, 2005 - Drobeta Turnu-Severin (1963).

Protection status: NT (SZÉKELY, 2008).

Distribution: Transylvania Plain, Southern Transylvania, Crişana (SZÉKELY, 2008).

The species was not found again in the analysed material. Only one specimen is preserved in the museum heritage in the "Ion Stănoiu" Collection.

Genus *Brintesia* FRUHSTORFER 1911

B. circe panonica (FRUHSTORFER 1911)

Previous reports from the Oltenia fauna: STĂNOIU & BOBÎRNAC, 1965 - Novaci (1957); STĂNOIU et al., 1978 - Craiova surrounding forests (1977); RAKOSY et al., 2003 - Oltenia (1901-1980); CHIMIŞLIU & GOGA, 2005 - Drobeta Turnu-Severin (1963), Cernele Forest (1966), Cobia Forest (1968), Palilula Forest (1967), Perişor Forest (1967), Novaci (1967).

Examined material - 8 specs.: Bucovăţ (forest) 1 spec. June 19, 1968 P.I.; 1 spec. July 4, 1982 V.A.; 2 specs. July 10, 1982 C.C.; 2 specs. August 27, 1982 C.C.; 1 spec. July 5, 2005 C.C.; Leamna 1 spec. July 2, 2003 V.A.

Protection status: NT (SZÉKELY, 2008).

Distribution: Northern Oltenia, Banat, Crişana, Southern Transylvania, Dobrogea (SZÉKELY, 2008). The species is found also in the central part of Oltenia.

Genus *Minois* HUBNER 1819

M. dryas (SCOPOLI 1763)

Previous reports from the Oltenia fauna: STĂNOIU & BOBIRNAC, 1965 - Baia de Fier (1957); STĂNOIU et al., 1978 - Craiova surrounding forests (1977); RAKOSY et al., 2003 - Oltenia (1901-1980).

Examined material - 16 specs.: Bucovăţ 2 specs. July 11, 1978 V.A.; 4 specs. July 21, 1980 C.C.; 1 spec. July 4, 1982 C.C.; 1 spec. August 23, 1982 C.C.; 1 spec. August 21, 1989 C.C.; 3 specs. July 16 2003 B.L.; Craiova 1 spec. August 5, 1951 F.I.; 1 spec. June 26, 1991 V.A.; Leamna 2 specs. July 31, 2001 C.C. and B.L.

Protection status: LC (SZÉKELY, 2008).

Distribution: Throughout Romania except Southern Oltenia and Southern Banat (SZÉKELY, 2008).

Specimens collected during 1951-2001 are preserved in the museum heritage.

In the analysed material (379 specimens), The Maniolini tribe is the best represented (173 specimens belonging to 5 species and subspecies, included in 4 genera).

The most represented subspecies is *Maniola jurtina jurtina* (148 specs.), followed by the species *Melanargia galathea* (59 specs.), and *Coenonympha pamphilus* (41 specs.).

From the endangerment degree (IUCN) point of view, the 32 identified species and subspecies are: one critically endangered species (CR), 5 endangered species (EN), 6 vulnerable species (VU), 5 near threatened species (NT); 15 least concern species (LC).

Kirinia roxelana is a protected species by the European legislation.

The 32 species identified in Oltenia fauna represents 66.66% of the Satyrinae species mentioned in the fauna of Romania. Considering that the surface of Oltenia is about 11% of Romania's surface, the presence of 66.66% of this group of lepidopteran in Oltenia fauna shows the great diversity of this area.

From the 32 species and subspecies present in the Oltenia fauna, 25 are preserved in the museum heritage. Seven species (*Lopinga achine, Erebia euryale syrmia, E. manto trajanus, E. sudetica radnaensis, Hyponephele lycaon, H. lupinus, Arethusana arethusa*) mentioned by other authors in Oltenia fauna are not present in the museum collections.

Three species previously mentioned from the museum heritage (CHIMIŞLIU & GOGA, 2005) had not been found again in the analysed material: *Kirinia roxelana, Hypparchia statilinus*, and *Chazara briseis.*

The identification of 43 new sites increases the number of the collection sites known from Oltenia from 55 to 98, contributing to a better understanding of the species distribution in Romania.

Most of the collection sites are from Dolj County, followed by Gorj County. Amongst the counties of Oltenia, the least studied and known in entomofaunistic terms is Olt County.

CONCLUSIONS

The data obtained by processing the material preserved in the museum heritage lead to a better knowledge of the habitat area of the Satyrinae subfamily species in Oltenia fauna and implicitly of Romania and to a better knowledge of their diversity in this area.

The *leucomelas* form of the *Melanargia galathea* species is mentioned for the first time.

The obtained data regarding the diversity and distribution of the Satyrinae reconfirm the importance of entomological museum collections in scientific knowledge of biodiversity.

The presence of the species with different degrees of endangerment in the heritage museum, along with other rare species, increases its scientific value.

We consider that further taxonomic studies on the Satyrinae are needed in order to know their real diversity and distribution, and also for the completion of the museum heritage with the species which were reported in the literature but miss from the museum heritage.

REFERENCES

ALESINSCHI AL. & PEIU M. 1954. *Contribuţii la cunoaşterea lepidopterelor din Oltenia. (Comuna Căciulăteşti şi pădurile Roaba şi Sadova, regiunea Craiova).* Buletin Ştiinţific. Secţiunea Ştiinţe Agronomice, Geologice şi Geografice. Edit. Academiei R.P.R. Bucureşti. **6**(1): 319-328.

ALESINSCHI AL. & KÖNIG FR. 1963. *Contribuţiuni la cunoaşterea faunei de lepidoptere din munţii Lotru şi Parâng.* Comunicări de zoologie. Societatea de Ştiinţe Naturale şi Geografice din R.P.R., Bucureşti. **2**:137-149.

BOBÎRNAC B. 1962. *Contribuţii la cunoaşterea entomofaunei.* In: Pajiştile din Masivul Parâng şi îmbunătăţirea lor. Edit. Agro-silvică. Institutul Agronomic Craiova: 103-113.

BOBÎRNAC B. & SANDA EMILIA. 1964. *Contribuţii la cunoaşterea entomofaunei.* Buletinul Ştiinţific al Institutului Agronomic "Tudor Vladimirescu", Craiova. **7**: 169-184.

BOBÎRNAC B., STĂNOIU I., COSTESCU C. 1966. *Contribuţii la cunoaşterea entomofaunei zonei subcarpatice a Olteniei (I).* Buletin Ştiinţific. Institutul Agronomic, Craiova. **8**: 347-62.

BOBÎRNAC B. & STĂNOIU I. 1967. *Contribuţii la cunoaşterea entomofaunei Masivului Parâng (II).* Buletin Ştiinţific. Universitatea din Craiova. **9**: 399-409.

BOBÎRNAC B., MATEI IULIA, IONESCU ŞT., COSTESCU C. 1969. *Contribuţii la cunoaşterea entomofaunei zonei subcarpatice a Olteniei (Nota II).* Analele Universităţii. Craiova. Edit. Ceres, Bucureşti: **11**: 471-484.

BOBÎRNAC B., BOBÎRNAC LILIANA, MATEI IULIA. 1970. *Cu privire la ecologia unor coleoptere şi lepidoptere în condiţiile Olteniei (I).* Studii şi cercercetări. Muzeul Olteniei Craiova: 86-95.

BOBÎRNC B., STĂNOIU I., MATEI IULIA, COSTESCU C. 1971. *Contribuţii la cunoaştera entomofaunei din zona montană a Olteniei (Nota a III-a).* Studii şi cercetări. Subcomisia Monumentelor Naturii a Olteniei. Consiliul pentru Ocrotirea Monumentelor Naturii al Judeţului Dolj. Craiova: 147-155.

BOBÎRNAC B. & MATEI IULIA. 1983. *Contribuţii la studiul entomofaunei unor culturi horticole din Oltenia.* Lucrările celei de-a III-a Conferinţe de Entomologie. Iaşi: 361-364.

CHIMIŞLIU CORNELIA. 1989. *Colecţia de lepidoptere „M. Peiu" conservată la Muzeul de Ştiinţele Naturii Craiova.* Oltenia. Studii şi comunicări. Arheologie şi Istorie, Etnografie, Artă, Ştiinţele Naturii. Complexul Muzeal Judeţean Dolj. Craiova: 163-188.

CHIMIŞLIU CORNELIA. 1996. *Microlepidoptere conservate în Colecţia entomologică „I. Firu" a Muzeului de Ştiinţele Naturii Craiova.* Naturalia. Asociaţia Muzeografilor Naturalişti din România. Piteşti. **2-3**: 543-548.

CHIMIŞLIU CORNELIA. 2006. *Lepidoptera (Insecta: Lepidoptera) from Romania preserved in the „Ion Firu" Entomological Collection from the patrimony of the Oltenia Museum Craiova.* Entomologica romanica. Societatea Lepidopterologică Română. Cluj-Napoca. **11**: 55-68.

CHIMIŞLIU CORNELIA. 2008. *Contributions to the knowledge of the diversity of the papilionide (Insecta: Lepidoptera: Papilionoidea: Papilionidae) from Romanian's Fauna.* Analele Ştiinţifice ale Universităţii „Al. I. Cuza", Iaşi. (Serie nouă). Lucrările Simpozionului „Entomofagii şi rolul lor in păstrarea echilibrului natural". Edit. Universităţii „Al. I. Cuza", Iaşi: 169-174.

CHIMIŞLIU CORNELIA. 2009. *Contribuţii la cunoaşterea diversităţii pieridelor (Lepidoptera: Pieridae) din fauna Olteniei, România.* Diversitatea, valorificarea raţională şi protecţia lumii animale. Simpozion internaţional consacrat celei de-a 70-a aniversări din ziua naşterii prof. univ. Andrei Munteanu. Ştiinţa, Chişinău: 154-160.

CHIMIŞLIU CORNELIA. 2010 *Contribuţii la cunoaşterea familiei Sphingidae (Lepidoptera: Bombycoidea) din fauna Olteniei, România.* Buletin Ştiinţific. Revistă de Etnografie, Ştiinţele Naturii şi Muzeologie, Serie nouă. Ştiinţele Naturii. Muzeul Naţional de Etnografie şi Istorie Naturală, Chişinău. **12**(25): 55-63

CHIMIŞLIU CORNELIA. 2011. *New data regarding the diversity of the Nymphalidae Family (Insecta: Lepidoptera) in the Oltenia fauna, România (I).* Volumul de lucrări al Simpozionului „Biodiversitatea şi Managementul Insectelor din România". Suceava, 24-25 septembrie 2010. În memoria entomologului bucovinean Ioan Nemeş. Univ. „Ştefan cel Mare" din Suceava, Facultatea de Silvicultură şi Societatea Lepidopterologică Română: 8-63.

CHIMIŞLIU CORNELIA & GOGA CLAUDIA IONELIA. 2005. *Catalogul macrolepidopterelor Donaţiei „Ioan Stănoiu", conservată în patrimoniul Secţiei de Ştiinţele Naturii a Muzeului Olteniei Craiova.* Studii şi comunicări Complexul Muzeal de Ştiinţele Naturii „Ion Borcea", Bacău. **20**: 103-120.

KÖNIG FR. 1953. *Noi contribuţii pentru cunoaşterea macrolepidopterelor regiunii Băilor Herculane şi Orşova.* Buletin Ştiinţific. Secţiunea de Ştiinţe Biologice, Agronomice, Geologice şi Geografice. Edit. Academiei R.P.R., Bucureşti. **5**(3): 511-524.

LAMPERT K. 1923. *Die Grosschmetterlinge und Raupen Mitteleuropas.* Verlag von I. F. Schreiber in Esslingen und München. Ed. 2: 91-99.

MARCU O. 1929. *Contribuţii la cunoaşterea faunei Olteniei.* Arhivele Olteniei, Craiova. an **VIII** sept.- dec. nr. 45-46: 474-479.

POPESCU-GORJ A. 1955. *Revizuirea speciilor genului Erebia Dalm. din Carpaţii româneşti.* Buletin ştiinţific. Secţia de Biologie şi Ştiinţe Agricole şi Secţia de Geologie şi Geografie. Edit. Academiei R.P.R. Bucureşti. **7**(3): 717-752.

RAKOSY L., GOIA M., KOVACS Z. 2003. *Catalogul lepidopterelor României / Verzeichnis der Schmetterlinge Rumänien.* Societatea Lepidopterologică Română. Cluj-Napoca. 448 pp.

RAKOSY L. 2007. *Ordinul Lepidoptera.* In: Lista faunistică a României (specii terestre şi de apa dulce)/Checklist of Romanian Fauna (terrestrial and feshwater species). Ed. Moldovan T. Oana. Casa Cărţii de Ştiinţă, Cluj-Napoca: 310-365.

STĂNOIU I. & BOBÎRNAC B. 1965. *Contribuţii la studiul lepidopterelor din Oltenia.* Comunicări de zoologie Societatea de Ştiinţe Naturale şi Geografie din R.S.R. **3**: 215-226.

STĂNOIU I., BOBÎRNAC B., OLARU N. 1973. *Cercetări asupra faunei de lepidoptere din nord-estul Olteniei (Nota I).* Studii şi cercetări. Consiliul Culturii şi Educaţiei Socialiste a judeţului Vâlcea. Râmnicu Vâlcea: 220-225.

STĂNOIU I., BOBÎRNAC B., COPĂCESCU S. 1978. *Noi date asupra macrolepidopterelor din Oltenia (Nota V).* Studii şi cercetări. Consiliul Culturii şi Educaţiei Socialiste a judeţului Gorj. Târgu Jiu: 237-244.

STĂNOIU I., BOBÎRNAC B., COPĂCESCU S. 1979. *Fluturi din România.* Edit. Scrisul Românesc, Craiova: 70, 106, 126-127, 153, 175.

SZÉKELY L. 2008. *The Butterflies of Romania / Fluturii de zi din România.* Muzeul Judeţean de Istorie, Braşov. Tipografia Brastar Print Braşov: 144-193.

VAN SWAAY C. A. M. & WARREN M. S. 1999. *Red Data book of European butterflies. Rhopalocera).* Nature and Environment, Council of Europe Publishing. Strasbourg. 99. 260 pp.

***. *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* (Habitats Directive). http://europa.eu.int/comm/environment/nature/hab-an5en.htm. (accessed: March, 2010)

***. http//www.faunaeur.org (accessed: March, 2010).

Chimişliu Cornelia
The Oltenia Museum Craiova, Popa Şapcă Str., No. 8,
200422 Craiova, Romania
E-mail: chimisliu_cornelia@yahoo.com

Received: March 20, 2011
Accepted: July 6, 2011

STUDY ON THE MACROLEPIDOPTERA COLLECTED FROM THE DUMBRAVA SIBIULUI FOREST EXISTING WITHIN THE COLLECTION OF DR. VIKTOR WEINDEL

STANCĂ-MOISE Cristina

Abstract. This paper is part of a very large study involving research on the Macrolepidoptera species collected in the past and present along the perimeter of the "Sibiu Forest Grove". This study aims to prepare the red list of endangered or extinct species of this forest area. To prepare this study it was necessary to study the past collections, gathered by Saxon Macrolepidopterologists in Sibiu, Czekelius Daniel (1880-1938), Eugen Worell (1900-1958), Viktor Weindel (1903-1964), Heinrich von Hann Hannenheim (1922-1964), Rolf Weyrauch (1949-1978); these collections are available now at the Natural History Museum in Sibiu. This paper presents a systematic list of Macrolepidoptera from the Sibiu Forest Grove, Sibiu, from Viktor Weindel's collection.

Keywords: Macrolepidoptera, Dumbrava Sibiului Forest, Viktor Weindel collections.

Rezumat. Studiu privind speciile de Macrolepidoptere colectate din Pădurea Dumbrava Sibiului existente în colecţia Dr. Viktor Weindel. Prezenta lucrare face parte dintr-un studiu desfăşurat pe parcursul mai multor ani, legat de speciile de Macrolepidoptere colectate în trecut şi în prezent din perimetrul Pădurii „Dumbrava Sibiu". Acest studiu îşi propune să finalizeze „Lista roşie" a speciilor periclitate sau dispărute din zona Pădurii „Dumbrava Sibiu". Pentru elaborarea acestui studiu a fost necesar cercetarea colecţiilor din trecut ale saşilor din Sibiu. Colecţiile studiate aparţin: Daniel Czekelius (1880-1938), Eugen Worell (1900-1958), Viktor Weindel (1903-1964), Heinrich von Hann Hannenheim (1922-1964), Rolf Weyrauch (1949-1978), aceste colecţii se găsesc în prezent la Muzeul de Istorie Naturală din Sibiu. Prezenta lucrare cuprinde doar lista sistematică a macrolepidopterelor existente în colecţia lui Viktor Weindel, specii colectate din perimetrul Pădurii „Dumbrava Sibiului".

Cuvinte cheie: Macrolepidoptere, Pădurea „Dumbrava Sibiului", colecţia lui Viktor Weindel.

INTRODUCTION

Currently, fauna and ecological analysis of the reserve landscape show a great scientific and practical interest for Romania. The results can substantially contribute to the assessment of the conditions and evolution of entomofaunal ecosystems, as well as to the assessment of the climate quantitative and qualitative changes. In the present investigation there was systematically studied the families of Lepidoptera in Sibiu Forest Grove, according to the existing material in Viktor Waindel's collection.

Viktor Weindel (1887-1966)

Dr. Viktor Weindel is closely linked to the history of medicine in Sibiu. He had extremely varied activity both as a doctor and within the framework of for the Society of Natural Sciences. Born in Sibiu, he graduated from the secondary school here and after studying at the Faculty of Medicine in Cluj-Napoca, Budapest, and Munich, he was designated as a secondary doctor at Franz-Joseph hospital. He took part in the War of 1914-1918 until the last day as a doctor while continuing his activity at the hospital as well. As a lepidopterist collector, he began as a child. The oldest specimens in his collection are from the beginning of the last century. Even if it is not a large collection in Sibiu, however, it contains specimens gathered over a period of 60 years from many places. Thus, there are specimens collected from more distant surroundings of Sibiu, from south and east Transylvania, from Turnu Rosu and the hilly region. In a note entitled "The origin of my butterfly collection", he writes: 'The cardinal points of my collecting work are: Sibiu, Gusterita Vineyards Sibiu Cisnădioara, Sibiu Forest Grove, Sadu, Cisnădie, Păltiniş Magura Cisnădiei". After his retirement due to his serious illness, the arrangement and processing of the collection were not done. Thus, the collection arrived at the Museum in a less ordered state. Here, there were ordered 4,322 specimens of Macro- and Microlepidoptera collected between 1900 and 1959 from Transylvania (Sibiu and around the city). SCHNEIDER (1984) published a list with the material of Lepidoptera, collected from other geographical areas of Romania. There are more than 42 works noted on a list in Weindel's handwriting. There are noted almost exclusively medicine issues, as there is no title on Lepidoptera, only the 80-year anniversary of his Czekelius (WEINDEL, 1935, 1936) and his obituary (WEINDEL, 1937, 1938). This collection includes rare and very interesting in terms of collection biogeographic areas. Microlepidoptera collection has to be processed, updated, and published.

MATERIAL AND METHODS

The presented material comes from the entomological collection of Viktor Weindel, preserved in the Natural Museum in Sibiu in store. The 3,490 specimens were collected during the years 1904-1954 by Viktor Weindel in the neighbourhood of Sibiu, specifically from the Forest Grove area. After consulting the collection, the determination was made after the copyright material, some species being updated according to the works of KOCH (1991), POPESCU-GORJ (1980), and reference papers in Romania, among which a Catalogue of Butterflies, RAKOSY et al. (2003).

The paper contains a systematic list of 142 Macrolepidopteran species with 385 specimens collected from the Forest Grove area of Sibiu, which are grouped into 10 families (Drepanidae, Thyatiridae, Geometridae, Sphingidae, Lymantriidae, Arctiidae, Hesperiidae, Papilionidae, Nymphalidae, Lycaenidae). For each species the following data are given: Genus, family, year, month and day of collecting. In some species, according to the author, it is not mentioned the collection day, month and year only.

RESULTS AND DISSCUTIONS

After analysing the material, these species previously reported by Viktor Waindel in the Forest Grove area have been identified (species list). The present scientific situation of the collection of Lepidoptera of Viktor Waindel currently found in the Museum of Natural History in Sibiu, is rendered in Table 1.

Table 1. Lepidoptera from the Collection of Dr. Viktor Weindel. / Tabel 1. Lepidoptere din colecția Dr. Viktor Weindel.

Superfamilies	Families	Number of species	%	Number of specimens	%
MACROLEPIDOPTERA					
BOMBYCOIDEA	Lasiocampidae	11	1.91	62	1.77
	Lemoniidae	1	0.17	9	0.25
	Saturnidae	3	0.52	9	0.25
DREPANOIDEA	Drepanidae	3	0.52	12	0.34
	Thyatridae	4	0.69	9	0.25
GEOMETROIDEA	Geometridae	170	29.66	773	22.14
SPHINGOIDEA	Sphingidae	19	3.31	52	1.48
NOTODONTOIDEA	Notodontidae	17	2.96	49	1.40
	Dilobidae	1	0.17	1	0.02
	Thaumatopoeidae	1	0.17	2	0.05
NOCTUIDEA	Lymantriidae	10	1.74	62	1.77
	Arctiidae	26	4.53	102	2.92
	Ctenuchidae	2	0.34	16	0.45
	Nolidae	1	0.17	2	0.05
	Noctuidae	178	31.06	634	18.16
HESPERIOIDEA	Hesperiidae	12	2.09	117	3.35
PAPILIONOIDEA	Papilionidae	6	1.04	88	2.52
	Pieridae	13	2.26	307	8.79
	Nymphalidae	38	6.63	420	12.03
	Satyridae	22	3.83	359	10.28
	Riodinidae	1	0.17	12	0.34
	Lycaenidae	34	5.93	393	11.26
TOTAL		**573**	**100%**	**3490**	**%**

List of Macrolepidoptera species collected from the Sibiu Forest Grove present in the Collection of Viktor Waindel:

Superfamily GEOMETROIDEA
Family DREPANIDAE
Genus ***Cilix*** LEACH, 1815 (*Euclea* HÜBNER [1819])
1. *Cilix glaucata* SCOPOLI 1763
Material examined: 1 specimen, April 1920, VW.

Family THYATIRIDAE
Genus ***Tethea*** OCHSENHEIMER 1816
(syn. *palimpsestis* HÜBNER [1821]; *bombycia* HÜBNER [1821];
Ceropacha STEPHENS 1829; *Ceratopacha* STEPHENS, 1850)
2. *Tethea or or* DENIS & SCHIFFERMÜLLER 1775 (syn. *Cymatophora or* FABRICIUS)
Material examined: 1 spec., July 25, 1904, VW; 1 spec., May 18, 1904, VW; P"DS".

Family GEOMETRIDAE
Subfamily Archiearinae
(syn. Brephinae)
Genus ***Archiearis*** HUBNER 1823
3. *Archiearis parthenias* LINNAEUS 1761
Material examined: 2 specs., March 12, 1922; March 29, 1923, VW.
4. *Archiearis notha* HÜBNER [1803]
Material examined: 3 specs., March 12, 1923, VW.

Subfamilia OENOCHROMINAE
Genus ***Alsophila*** HÜBNER 1825
(*Anisopteryx* auct.)
5. *Alsophila aescularia* DENIS & SCHIFFERMÜLLER 1775
Material examined: 2 specs., March 12, 1922, VW.

Subfamily Geometrinae

Genus ***Geometra*** LINNAEUS 1758

(syn. *Hipparchus* LEACH [1815]; *Leprtornis* BILLBERG 1820; *Holothalassis* HÜBNER [1823])

Genus ***Pseudoterpna*** HUBNER 1823

6. *Pseudoterpna pruinata* HUFNAGEL 1767

Material examined: 1 spec., July 9, 1907, VW.

Genus ***Chlorissa*** STEPHENS 1831

(syn. *Nemoria* auct.)

7. *Chlorissa viridata* LINNAEUS 1758

Material examined: 1 spec., June 18, 1903, VW.

Genus ***Cyclophora*** HÜBNER 1822

(syn. *Cosymbia* HÜBNER 1823; *Leucophthalmia* HÜBNER 1823; *Codonia* HÜBNER 1825; *Ephyra* DUPONCHEL 1829; *Zonosoma* LEDERER 1853)

8. *Cyclophora punctaria* LINNAEUS 1758

Material examined: 1 spec., April 27, 1904, VW.

Subfamily Sterrhinae

Genus ***Timandra*** DUPONCHEL 1829

(syn . *Calothysanis* auct.; *Bradyepetes* STEPHENS1813)

9. *Timandra griseata* W. PETERSEN 1902

(syn. *Calothysanis amata* auct.)

Material examined: 1 spec., July 7, 1907, VW.

Genus ***Scopula*** SCHRANK 1802

(syn. *Calothysanis* HÜBNER 1823; *Acidalia* TREITSCHKE 1825; *Leptomeris* HÜBNER [1825]; *Craspedia* HÜBNER [1825]; *Dosithea* DUPONCHEL1829; *Cymatida* SODOFFSKY1837; *Sidonia* DUPONCHEL1842; *Pylarge* HERRICH-SCHÄFFER1856)

10. *Scopula immorata* LINNAEUS 1758

Material examined: 3 specs., July 10, 1923; June 18, 1903, VW; June 19, 1907, VW.

11. *Scopula nigropunctata* HUFNAGEL 1767

(syn. *S. strigilaria* auct.)

Material examined: 1 spec., July 9, 1907, VW.

12. *Scopula decorata decorata* DENIS & SCHIFFERMÜLLER 1775

(syn. *Acidalia violata* TREITSCHKE 1825)

Material examined: 1 spec., March 6, 1904, VW.

Genus ***Idaea*** TREITSCHKE, 1825

(syn. *Sterrha* HÜBNER [1825]; *Arrhostia* HÜBNER [1825]; *Ptychopoda* CURTIS 1826; *Hyria* STEPHENS 1829; *Ania* TEPHENS 1831; *Antesis* WARREN 1900)

13. *Idaea aversata aversata* LINNAEUS 1758

Material examined: 1 spec., March 6, 1904, VW.

14. *Idaea ochrata* SCOPOLI 1763

Material examined: 3 specs., June 18, 1903; June 19, 1907; July 7, 1908, VW.

Subfamily Larentiinae

Genus ***Lythria*** HÜBNER [1823]

15. *Lythria purpuraria* LINNAEUS 1758

Material examined: 1 spec., July 14, 1904, VW.

Genus ***Scotopteryx*** HÜBNER [1825]

(syn. *Ortholitha* auct.; *Onychia* HÜBNER [1825]; *Phasiane* DUPONCHEL 1829; *Eubolia* DUPONCHEL 1829; *Eusebia* DUPONCHEL [1845])

16. *Scotopteryx luridata* HUFNAGEL 1767

(syn. *Ortholitha plumbaria* FABRICIUS 1775)

Material examined: 2 specs, May 21, 1904; June 7, 1953, VW.

Genus ***Xanthorhoe*** HÜBNER [1825]

(syn. *Melenydris* HÜBNER [1825]; *Ochyria* HÜBNER [1825]; *Coremia* GUENÉE 1845; *Boremia,* erreur)

17. *Xanthorhoe ferrugata* CLERCK 1759

(syn. *X. unidentaria* HAWORTH 1809)

Material examined: 1 spec., June 18, leg. Czekelius (collection does not appear on the label of the collection year), VW.

Genus ***Epirrhoe*** HÜBNER [1825]

18. *Epirrhoe alternata* MÜLLER 1764

(syn. *E. sociata* BORKHAUSEN 1794)

Material examined: 1 spec., June 19, 1907, VW.

19. *Epirrhoe tristata* LINNAEUS 1758

Material examined: 2 specs., May 29, 1903, VW.

Genus ***Camptogramma*** STEPHENS 1831

20. *Camptogramma bilineata* LINNAEUS 1758

Material examined: 1 spec., June 17, 1923, VW.

Genus ***Pelurga*** HÜBNER [1825]

(syn. *Electra* STEPHENS 1829)

21. *Pelurga comitata* LINNAEUS 1758

Material examined: 1 spec., March 13, 1904, VW.

Genus ***Philereme*** HÜBNER [1825]

(syn. *Scotosia* STEPHENS 1829)

22. *Philereme vetulata* DENIS & SCHIFFERMÜLLER 1775

Material examined: 2 specs., May 29, 1921; July 24, 1904, VW.

Genus ***Operophtera*** HÜBNER [1825]

(syn. *Operophtera* HÜBNER [1826])

23. *Operophtera brumata* LINNAEUS 1758

Material examined: 17 specs., December 2, 1956, VW.

Genus ***Perizoma*** HÜBNER [1825]

(*Mesotype* HÜBNER [1825]; *Emmelesia* STEPHENS, 1831)

24. *Perizoma alchemillata* LINNAEUS 1758

Material examined: 2 spec., July 9, 1907; March 10, 1904, VW.

Genus ***Odezia*** BOISDUVAL 1840

(syn. *Tanagra* DUPONCEL 1829; nec. LINNAEUS 1764)

25. *Odezia atrata* LINNAEUS 1758

Material examined: 1 spec., June 13, 1907, VW.

Genus ***Lomaspilis*** HÜBNER [1825]

(syn. *Poecilophasia* STEPHENS 1831)

26. *Lomaspilis marginata* LINNAEUS 1758

Material examined: 1 spec., May 12, 1904, VW.

Genus ***Plagodis*** HÜBNER [1823]

(*Anagoga* HÜBNER [1823], *Anagoge,* erreur; *Azinephora* STEPHENS 1827; *Eurymene* DUPONCHEL 1829; *Numeria* DUPONCHEL 1829)

27. *Plagodis dolabraria* LINNAEUS 1767

Material examined: 1 spec., May 12, 1904, VW.

Genus ***Pseudopanthera*** HÜBNER [1823]

(syn. *Venilia* DUPONCHEL 1829)

28. *Pseudopanthera macularia* LINNAEUS 1758

Material examined: 3 specs., May 21; June 18, 1903; May 29, 1921, VW.

Genus ***Selenia*** HÜBNER [1823]

29. *Selenia tetralunaria* HUFNAGEL 1767

Material examined: 1 spec., July 25, 1904, VW.

Genus ***Colotois*** HÜBNER [1823]
(syn. *Metra* STEPHENS 1827; *Himera* DUPONCHEL 1829)
30. *Colotois pennaria* LINNAEUS 1761
Material examined: 1 spec., July 14, 1904, VW.
Genus ***Angerona*** DUPONCHEL 1829
31. *Angerona prunaria* LINNAEUS 1758
Material examined: 1 spec., June 13, 1907, VW.
Genus ***Biston*** LEACH [1815]
(syn. *Dasyphara* BILLBERG 1820; *Pachys* HÜBNER 1822; *Amphidasis* TREITSCHKE 1825; *Eubyja* HÜBNER [1825]; *Amphidasys* SODOFFSKY 1837)
32. *Biston betularia* LINNAEUS 1758
Material examined: 2 specs., July 19, 1904, VW.
33. *Biston strataria* HUFNAGEL 1767
Material examined: 2 specs., March 26, 1904, VW.
Genus ***Agriopis*** HÜBNER [1825]
(syn. *Anisopteryx* STEPHENS 1827; *Cryopega* DUMONT 1925)
34. *Agriopis marginaria* FABRICIUS 1777
Material examined: 2 specs., April 4, 1904; March 12, 1922, VW.

Subfamily Boarminae
Genus ***Boarmia*** TREITSCHK 1825
(*Dryocoetis* HÜBNER [1825])
35. *Boarmia roboraria* DENIS & SCHIFFERMÜLLER 1775
Material examined: 1 spec., May 30 (without collecting year), VW.
Genus ***Ematurga*** LEDERER 1853
36. *Ematurga atomaris atomaria* LINNAEUS 1758
Material examined: 3 specs., April 1920 (does not appear on the label collection); May 12, 1904, VW.
Genus ***Cabera*** TREITSCHKE 1825
(*Deilina* HÜBNER [1825])
37. *Cabera pusaria* LINNAEUS 1758
Material examined: 2 specs., May 12, 1904; June 18, 1903, VW.
Genus ***Campaea*** LAMARCK 1816
(*Tribacis* BILLBERG1816; *Metrocampus Berthold* in LATREILLE 1827; *Metrocampa* BRUAND 1846)
38. *Campaea margaritata* LINNAEUS 1767
Material examined: 1 spec., March 6, 1904, VW.
Genus ***Siona*** DUPONCHEL 1829
(syn. *Scoria* STEPHENS 1891)
39. *Siona lineata* SCOPOLI 1763
Material examined: 4 specs., June 17, 1923; May 29, 1921; June 13, 1904, VW.

Superfamily SPHINGOIDEA
Family SPHINGIDAE
Genus ***Agrius*** HÜBNER [1819]
(syn. *Herse* OKEN 1815, *Herse* AGASSIZ 1846)
Genus ***Sphinx*** LINNAEUS 1758
(*Spectrum* SCOPOLI 1777; *Lethia* HÜBNER [1819])
40. *Sphinx ligustri ligustri* LINNAEUS 1758
Material examined: 1 spec.; June 29, 1952 VW

Superfamily NOCTUOIDEA
Family LYMANTRIIDAE
Genus ***Orgya*** OCHSENHEIMER 1810
41. *Orgya antiqua* LINNAEUS 1758
Material examined: 1 spec., October 25, 1955, VW.
Genus ***Euproctis*** HÜBNER [1819]
(syn. *Liparis* OCHSENHEIMER 1810; *Nygmia* HÜBNER [1820]; *Porthesia* STEPHENS 1828)
42. *Euproctis similis* FUESSLY 1775
Material examined: 2 specs., July 7, 1908; July 27, 1904, VW.

Family ARCTIIDAE
Subfamily Lithosiinae
Genus ***Eilema*** HÜBNER [1819]
(syn. *Systropha* HÜBNER [1819]; *Piesta* BILLBERG 1820; *Ilema* HAMPSON 1900; *Colinia* AGENJO 1977, nec. COSSMANN, 1906, nec. NUTTALL, 1832)
43. *Eilema sororcula* HUFNAGEL 1766
Material examined: 5 specs., May 29, 1921, VW.
44. *Eilema lurideola* ZINCKEN 1817
Material examined: 1 spec., July 19, 1907, VW.

Subfamily Arctiinae
Genus ***Arctinia*** EICHWALD 1830
(syn. *Phragmatobia* STEPHENS 1828)
45. *Arctinia caesarea* GÖEZE 1781
(syn. *Phragmatobia caesarea* GÖEZE 1781)
Material examined: 1 spec., May 21, 1904, VW.
Genus ***Diacrisia*** HÜBNER [1819]
(*Euthemonia* STEPHENS 1828; *Rhyparioides* BUTLER 1877)
46. *Diacrisia sannio* LINNAEUS 1758
Material examined: 3 specs., May 20, 1903; May 29, 1921; June 13, 1907, VW.

Subfamily Callimorphinae
Genus ***Callimorpha*** LATREILE 1809
(*Euplagia* HÜBNER 1820; *Panaxia* TAMS 1939)
47. *Callimorpha quadripunctaria* PODA 1761
Material examined: 2 specs., March 11, 1904; May15, 1903, VW.

Family NOCTUIDAE
Subfamily Noctuinae
(Trifinae)
Genus ***Agrotis*** OCHSENHEIMER 1816
(syn. *Scotia* HÜBNER [1821]; *Agronoma* HÜBNER [1821]; *Georyx* HÜBNER [1821]; *Noctua* BOISDUVAL 1828, nec. LINNAEUS 1758; *Psammophiila* STEPHENS 1850)
48. *Agrotis segetum* DENIS & SCHIFFERMÜLLER 1775
Material examined: 3 specs., May 18, 1904; May 21, 1938, VW.
49. *Agrotis ipsilon* HUFNAGEL 1766
Material examined: 2 specs., May18, 1904, VW 3 ex.; March 18, 1904, VW.
Genus ***Noctua*** LINNAEUS 1758
(syn. *Triphaena* OCHSENHEIMER 1816; *Lampra* HÜBNER [1820];
Euschesis HÜBNER [1821])
50. *Noctua pronuba* LINNAEUS 1758
Material examined: 2 specs., May 20, 1910, VW.
Genus ***Xestia*** HÜBNER 1818

(syn. *Amathes* HÜBNER [1821]; *Megasema* HÜBNER [1821]; *Lytaea* STEPHENS 1829; *Segetia* STEPHENS 1829)

51. *Xestia baja* DENIS & SCHIFFERMÜLLER 1775

Material examined: 4 specs., May 8, 1904; 17, May 18, 1904, VW.

Genus ***Naenia*** STEPHENS 1827

52. *Naenia typica* LINNAEUS 1758

Material examined: 1 spec., August 25, 1904, VW.

Subfamily Hadeninae

Genus ***Polia*** OCHSENHEIMER 1816

(*Aplecta* GUENÉE 1838)

53. *Polia nebulosa* HUFNAGEL 1766

Material examined: 1 spec., May 11, 1904, VW.

Genus ***Mamestra*** OCHSENHEIMER 1816

(syn. *Lacanobia* BILLBERG 1820; *Melanchra* HÜBNER [1820]; *Barathra* HÜBNER [1821]; *Diataraxia* HÜBNER [1821]; *Ceramica* GUENÉE 1852; *Hecatera* GUENÉE 1852; *Peucephila* HAMPSON 1909)

Subgenus ***Mamestra*** OCHSENHEIMER 1816

54. *Mamestra brassicae* LINNAEUS 1758

Material examined: 1 spec., May 18, 1904, VW.

Genus **Orthosia** OCHSENHEIMER 1816

(syn. Orthoa BILLBERG 1820; *Monima* HÜBNER 1821; *Cuphanoa* HÜBNER [1821]; *Semiophora* STEPHENS 1829; *Taeniocampa* GUENÉE 1839)

55. *Orthosia cruda* DENIS & SCHIFFERMÜLLER 1775 (syn. *Monima pulverulenta* ESPER 1786)

Material examined: 3 specs., 26, March 1904; 29 March, 1905; April 2 (without collecting year); April 4, 15, 1904, VW.

56. *Orthosia gracilis* DENIS & SCHIFFERMÜLLER 1775

Material examined: 1 ex.; April 2 (without collecting year) VW

57. *Orthosia munda* DENIS & SCHIFFERMÜLLER 1775

Material examined: 6 specs., March 26, 1904; March 29,30, 1904; April 13,15, 1904, VW.

58. *Orthosia gothica* LINNAEUS 1758

Material examined: 3 specs., April 13, 14. April, 1904, VW.

Genus ***Mythimna*** OCHSENHEIMER 1816

(syn. *Philostola* BILLBERG 1820; *Aletia* HÜBNER [1821]; *Hyperiodes* WARREN 1910; *Pseudaletia* FRANCLEMONT 1951; *Leucania* OCHSENHEIMER 1816; *Hyphilare* HÜBNER 1821)

Subgenus ***Mythimna*** OCHSENHEIMER 1816

59. *Mythimna conigera* DENIS & SCHIFFERMÜLLER 1775

Material examined: 1 spec., March 6, 1904, VW.

60. *Mythimna albipuncta* DENIS & SCHIFFERMÜLLER 1775

Material examined: 3 specs., March 1, 18, 24, 1904, VW.

Subfamily Cuculliinae

Genus ***Lithophane*** HÜBNER [1821]

(*Graptolitha* HÜBNER [1821]; *Rhizolitha* CURTIS [1830])

61. *Lithophane ornitopus* HUFNAGEL 1766

Material examined: 2 specs., April 15, 1904. VW.

Genus ***Eupsilia*** HÜBNER [1821]

(syn. *Scopelosoma* CURTIS 1837; *Mecoptera*, GUENÉE 1837)

62. *Eupsilia transversa* HUFNAGEL 1766

(syn. *E. satellitia* LINNAEUS 1767)

Material examined: 5 specs., March 16, 26, 1904, VW.

Genul ***Conistra*** HÜBNER 1821

(syn. *Orrhodia* HÜBNER [1821]; *Gloia* HÜBNER 1822; *Gleae*, erreur)

Subgenus ***Conistra*** HÜBNER 1821, s.str.

63. *Conistra (C.) vaccinii* LINNAEUS 1761

Material examined: 5 specs., March 11, 26, 1904; 5 specs., April 4, 9, 14, 5, 1904; March 29, 1905, VW.

64. *Conistra rubiginosa* SCOPOLII 1763

Material examined: 1 spec., March 26, 1904, VW.

Genus ***Dasycampa*** GUENÉE 1937

65. *Dasycampa erythrocephala* DENIS & SCHIFFERMÜLLER 1775

Material examined: 4 specs., March 29, 30, 1905; 4 specs., April 13,16, 1904; 1 spec., 9 March (without collecting year), VW.

Genus ***Acronicta*** OCHSENHEIMER 1816

(syn. *Apatele* HÜBNER 1822; *Acronycta* TREITSCHKE 1825)

Subgenus ***Viminia*** CHAPMAN 1890

(syn. *Pharetra* HÜBNER 1820, nec. BOLTER 1728)

66. *Acronicta (Viminia) rumicis rumicis* LINNAEUS 1758

Material examined: 1 spec., April 25, 1904, VW.

Genus ***Craniophora*** SNELLEN 1867

(syn. *Bisulcia* CHAPMAN 1890)

67. *Craniophora ligustri* DENIS & SCHIFFERMÜLLER 1775

Material examined: 2 specs., March 6, 8, 1904, VW.

Subfamily Amphipyrinae

Genus ***Amphipyra*** OCHSENHEIMER 1816

(*Scotophila* HÜBNER [1821]; *Pyrophila* STEPHENS 1829; *Philopry* GUENÉE 1837)

68. *Amphipyra pyramidea* LINNAEUS 1758

Material examined: 2 specs., May 6, 1904, VW.

Genus ***Rusina*** STEPHENS 1829

(syn. *Stygiostola* HAMPSON 1908)

69. *Rusina ferruginea* ESPER 1785

Material examined: 1 spec., May 6, 1904, VW.

Genus ***Thalpophila*** HÜBNER 1820

(*Cerigo* STEPHENS, 1829)

70. *Thalpophila matura matura* HUFNAGEL 1776

Material examined: 2 specs., May 17, 1904, VW.

Genus ***Trachea*** OCHSENHEIMER 1816

(*Achatis* BILLBERG 1820)

71. *Trachea atriplicis* LINNAEUS 1758

Material examined: 1 spec., May 18, 1904, VW.

Genus ***Cosmia*** OCHSENHEIMER 1816

(syn. *Eustehnia* HÜBNER 1821)

Subgenus ***Cosmia*** OCHSENHEIMER 1816

72. *Cosmia (Calymnia) trapezina* LINNAEUS 1758

Material examined: 2 specs., May 17, 18 1904, VW.

Genus ***Apamea*** OCHSENHEIMER 1816

(syn. *Abromias* BILLBERG 1820; *Septis* HÜBNER [1821]; *Xylophasia* STEPHENS 1819; *Hana* STEPHENS

1829; *Crymodes* GUENÉE 1841; *Syma* STEPHENS 1850, nec. LESSON 1827)

73. *Apamea monoglypha monoglypha* HUFNAGEL 1766

Material examined: 1 spec., May 27, 1904, VW.

Genus ***Mesapamea*** HEINICKE 1959

74. *Mesapamea secalis* LINNAEUS 1758

Material examined: 2 specs., May 17, 18, 1904, VW.

Genus ***Amphipoea*** BILLBERG 1820

75. *Amphipoea oculea oculea* LINNAEUS 1761

Material examined: 1 spec., May 11, 1904, VW.

Genus ***Hoplodrina*** BOURSIN 1937

76. *Hoplodrina blanda* DENIS & SCHIFFERMÜLLER 1775 (syn. *H. taraxaci* HÜBNER 1813)

Material examined: 3 specs., May 8, 11, 27, 1904, VW.

Subfamily Catocalinae

Genus ***Catocala*** SCHRANK 1802

(syn. *Astiotes* HÜBNER 1823, *Hemigeometra* HAWORTH 1809, *Mormonia* HÜBNER [1823])

77. *Catocala sposa* LINNAEUS 1767

Material examined: 3 specs., July 23, 1907; 26.VII.1904; 2 specs., May 8, 11, 1904, VW.

78. *Catocala elocata* ESPER 1788

Material examined: 1 spec., May 16, 1904, VW.

79. *Catocala promissa* DENIS & SCHIFFERMÜLLER 1775

Material examined: 2 specs., July 8, 1907, VW.

Genus ***Minucia*** MOORE 1885

(syn. *Ophiodes* GUENÉE 1841; *Pseudophia* GUENÉE 1852; *Anua* WALKER 1858)

80. *Minucia lunaris* DENIS & SCHIFFERMÜLLER 1775

Material examined: 1 spec., May 3, 1912, VW.

Genus ***Euclidia*** OCHSENHEIMER 1816

(syn. *Ectypa* BILLBERG 1820)

81. *Euclidia glyphica* LINNAEUS 1758

Material examined: 1 spec., April 1920 (without collecting year), VW.

Subfamily Ophiderinae

Genus ***Scoliopteryx*** GERMAR 1811

(syn. *Pterodonta* REICHENBACH LEIPZIG1817; *Ephenias* HÜBNER 1821; *Euphais* HÜBNER 1822; *Gonoptera* BERTHOLD in LATREILLE 1827, nec. BILLBERG 1820)

82. *Scoliopteryx libatrix* LINNAEUS 1758

Material examined: 1 spec., April 15, 1904, VW.

Genus ***Phytometra*** HAWORTH 1809

(syn. *Prothyminia* HÜBNER 1823; *Antarchaea*, auct.)

83. *Phytometra viridaria* CLERCK 1759

Material examined: 2 specs., April 1920 (without collecting year), VW.

Subfamily Hypeninae

Genus ***Polypogon*** SCHRANK 1802

84. *Polypogon tentacularia* LINNAEUS 1758

Material examined: 4 specs., May 29, 1921; June 10, 1923; June 19, 1907, VW.

Genus ***Paracolax*** HÜBNER 1825

85. *Paracolax derivalis* HÜBNER 1796

Material examined: 1spec., July 14, 1904,VW.

Genus ***Hypena*** SCHRANK 1802

(syn. *Erichila* BILLBERG 1820; *Herpyzon* HÜBNER 1822)

86. *Hypena (H) proboscidalis* LINNAEUS 1758

Material examined: 1 spec., June14, 1903, VW.

Superfamily HESPERIOIDEA

Family HESPERIIDAE

Genus ***Erynnis*** SCHANK, 1801

(syn. *Thymele* FABRICIUS 1807; *Astycus* HÜBNER 1822; *Nisoniades* auct., *Thanaos* BOIDUVAL 1834)

87. *Erynnis tages tages* LINNAEUS 1758

Material examined: 3 specs., July 23, 25, 1921; May 1, 1903, VW.

Genus ***Carcharodus*** HÜBNER 1819

(syn. *Spilothyrus* DUPONCHEL 1835; *Reverdinus* RAGUSA 1919; *Lavatheria* VERITY 1940)

88. *Carcharodus flocciferus flocciferus* ZELLER 1847 (syn. *C. altheae* HÜBNER 1803)

Material examined: 1 spec., June 13, 1907, VW.

Genus ***Pyrgus*** HÜBNER 1819

(syn. *Syrichtus* auct.; *Hemiteleomoepha* WARREN 1926)

89. *Pyrgus alveolus* HÜBNER 1803

Material examined: 2 specs., September 5 (without collecting year), July 9, 1907, VW.

Subfamily Hesperiinae

Genus ***Hesperia*** FABRICIUS 1793

(syn. *Pamphila* FABRICIUS 1807; *Urbicola* TUTT 1905; *Augiades* auct.)

90. *Hesperia comma comma* LINNAEUS 1758

Material examined: 4 specs., May 15, 1903, VW.

Genus ***Ochlodes*** SCUDDER 1872

91. *Ochlodes venatus faunus* TURATI 1905

(syn. *O. sylvanus* ESPER 1779)

Material examined: 4 specs., June 22, 1980; July 9, 19, 1907; May 1, 1903; May 14, 1904, VW.

Superfamily PAPILIONOIDEA

Family PAPILIONIDAE

Subfamily Papilioninae

Genus ***Papilio*** LINNAEUS 1758

(syn. *Pterourus* SCOPOLI 1777)

92. *Papilio machaon machaon* LINNAEUS 1758

Material examined: 2 specs., May 17, 1902; July 9, 1904, VW.

Genus ***Iphiclides*** HÜBNER 1819

93. *Iphiclides podalirius podalirius* SCOPOLI 1763

Material examined: 1spec., July 14, 1904, VW.

Family PIERIDAE

Subfamily Dismorphiinae

Genus ***Leptidea*** BILLBERG 1820

(syn. *Leucophasia* STEPHENS 1827; *Leptosia* auct.; *Letidia*, erreur)

94. *Leptidea sinapis diniensis* BOISDUVAL 1839

Material examined: 2 specs., July 4, 1904; July 7, 1908, VW; 4 specs., July 9, 1907; July 14, 1904; July 26, 1904; May 8, 1954, VW.

95. *Leptidea lathyri* HÜBNER 1819
Material examined: 3 specs., April 1920 (no collection day); May 21, 1921, VW.

Genus ***Aporia*** HÜBNER [1819]

96. *Aporia crataegi crataegi* LINNAEUS 1758
Material examined: 2 specs., June 12, 1904; June 13, 1907, VW.

Subfamily Pierinae

Genus ***Pieris*** SCHRANK 1801
(syn. *Ganoris* DALMAN 1816; *Andropodum* HUBNER 1822; *Tachyptera* BERGE 1842)

97. *Pieris brassicae brassicae* LINNAEUS 1758
Material examined: 68♀♀, 3 specs., May 21,1904; July 2; July 4; 2 specs., July 11; 5 specs., July 18; May 1, 1903, VW.

98. *Pieris rapae rapae* LINNAEUS 1758
Material examined: 3 specs., April, 1920 (non-collection day), May 11, 1955; May 21, 1904, VW.

99. *Pieris napi meridionalis* HEYNE 1895
Material examined: 2 specs., April 1920 (non-collection day); April 10, 1921, VW.

Genus ***Pontia*** FEBRICIUS 1807
(syn. *Leucochloë* RÖBER 1907)

100. *Pontia daplidice daplidice* LINNAEUS, 1758
Material examined: 1 spec., October 3, 1926, VW.

Genus ***Anthocharis*** BOISDUVAL RAMBUR &GRASLIN [1833]

101. *Anthocaris cardamines meridionalis* VERITY 1908
Material examined: 4 specs., April, 1920 (non-collection day); May 12, 1904; May 17, 1902; June 7, 1953, VW.

Subfamily Coliadinae

Genus ***Colias*** FABRICIUS 1807
(syn. *Zerene* HUBNER [1819]; *Eurymus* HORSFIELD nec.RAFINESQUE 1815)

102. *Colias hyale hyale* LINNAEUS 1758
Material examined: 1 spec., May 12, 1904; 5♂♂, July 11, July 22, May 15, 1903, VW.

103. *Colias myrmidone* ESPER,1803
Material examined: 2 specs., May 29, 1921, VW.

Family NYMPHALIDAE

Subfamily Nymphalinae

Genus ***Apatura*** FABRICIUS 1807
(syn. *Aeola* BILLBERG 1820)

104. *Apatura iris iris* LINNAEUS 1758
Material examined: 1 spec., July 14, 1904, VW.

105. *Apatura ilia ilia* DENIS & SCHIFFERMÜLLER 1775
Material examined: 1 spec., July 14, 1904, VW.

Genus ***Limenitis*** FABRICIUS 1807
(syn. *Nymphalus* BOITARD 1828; *Ladoga* MOORE [1898])

106. *Limenitis populi populi* LINNAEUS 1758
Material examined: 1 spec., June 12, 1904, VW.

Genus ***Nymphalis*** KLUK 1802
(syn. *Scudderia* GROTE 1873, nec. STÅL 1873; *Euvanessa* SCUDDER 1889)

107. *Nymphalis xanthomelas* DENIS & SCHIFFERMÜLLER 1775
Material examined: 2 specs., June 9, 1947, EW; July 9, 1904, VW.

Genus ***Vanessa*** FABRICIUS 1807
(syn. *Pyrameis* HÜBNER [1819])

108. *Vanesa cardui* LINNAEUS 1758
Material examined: 1 spec., July 30, 1907, VW.

Genus ***Aglais*** DALMAN 1816
(syn. *Ichnusa* REUSS 1939)

109. *Aglais urticae urticae* LINNAEUS 1758
Material examined: 1 spec., March 12, 1922, VW.

Genus ***Polygonia*** HÜBNER [1819]
(syn. *Eugonia* HÜBNER [1819])

110. *Polygonia c-album c-album* LINNAEUS 1758
Material examined: 4 specs., March 12, 1922; March 29, 1923; April 1920 (non-collection day); April 15, 1956; April 26, 1904, VW.

Genus ***Araschnia*** HÜBNER [1819]

111. *Araschnia levana levana* LINNAEUS 1758
Material examined: 3 specs., July 9, 1907; July 14, 1903; July 14, 1904, VW.

Genus ***Argynnis*** FABRICIUS 1807
Subgenus **Mesoacidalia** REUSS 1926

112. *Argynnis (Mesoacidalia) aglaja aglaja* LINNAEUS 1758 (syn. *M. charlotta* HAWORTH 1803)
Material examined: 2 specs., July 3, 1903; July 14, 1903, VW.

Subgenus ***Fabriciana*** REUSS 1920

113. *Argynnis (Fabriciana) addipe addipe* DENIS & SCHIFFERMÜLLER 1775
Material examined: 2 specs., June 10, 1923; July 31, 1903, VW.

114. *Argynnis (Fabriciana) niobe niobe* LINNAEUS 1758
Material examined: 1 spec., June 21, 1904, VW.

Subgenus ***Argynnis*** FABRICIUS 1807

115. *Argynnis (Argynnis) paphia paphia* LINNAEUS 1758
Material examined:2 specs., July 3, 1903; July 14, 1903, VW.

Genus ***Clossiana*** REUSS 1920

116. *Clossiana selene selene* DENIS & SCHIFFERMÜLLER 1775
Material examined: 3 specs., May 21, 1904; May 29, 1903; June 13, 1907, VW.

117. *Clossiana euphrosyne euphrosyne* LINNAEUS 1758
Material examined: 3 specs., May 21, 1904; June 13, 1907; June 7, 1953, VW.

Genus ***Issoria*** HÜBNER [1819]
(syn. *Rathora* MOORE [1900])

118. *Issoria lathonia lathonia* LINNAEUS 1758 (syn. *Argynnis lathoria* LINNAEUS 1758)
Material examined: 2 specs., April, 1920 (non-collection day); May 3, 15, 1903, VW.

Genus ***Melitaea*** FABRICIUS 1807
(syn. *Schoenis* HÜBNER [1819]; *Cinclidia* HÜBNER [1819]; *Didymaeformis* VERITY 1950; *Mellicta* BILLBERG 1820, part)

119. ***Melitaea cinxia cinxia*** LINNAEUS 1758
Material examined: 2 specs., July 3, 1903; June 12, 1904, VW.

120. ***Melitaea phoebe phoebe*** DENIS & SCHIFFERMÜLLER 1775
Material examined: 2 specs., June 12, 1904; July 3, 1904, VW.

121. ***Melitaea athalia athalia*** ROTTENBURG 1775
Material examined: 2 specs., May 21, 1904, VW; 3 specs., May 29, 1903, 1 spec., June 1, 1903, VW; 1 spec., June 3, 1907 VW; 2 specs., June 10, 1923 VW; 1 spec., June 12, 1904 VW; June 19, 1907 VW

122. ***Melitaea didyma didyma*** ESPER [1779]
Material examined: 1 spec., July 26, 1904, VW.

Genus ***Melanargia*** MEIGEN [1828]
(syn. *Agapetes* BILLBERG 1820, non. REJECT 1956)

123. ***Melanargia galathea scolis*** FRUHSTORFER 1917
Material examined: 1 spec., May 17, 1923; 3 specs., July 14, 1904, VW.

Genus ***Pararge*** HÜBNE [1819]
Subgenus ***Pararge*** HÜBNER 1819

124. ***Pararge (Pararge) aegeria tircis*** BUTLER 1867
Material examined: 4 specs., April 1920 (non-collection day); May 12, 1904; May 21, 1904, VW.

Subgenus ***Lasiommata*** HUMPHREYS & WESTWOOD 1841

125. ***Pararge (Lisiommata) megera megera*** LINNAEUS 1758
Material examined: 1 spec., May 21, 1904, VW.

Subgenus ***Lopinga*** MOORE [1895]

126. ***Parage (Lopinga) achine achine*** SCOPOLI 1763
Material examined: 2 specs., June 19, 1907, VW.

Genus ***Erebia*** DALMAN 1816

127. ***Erebia aethiops aethiops*** ESPER 1777
Material examined: 3 specs., May 10, August 2, 1 spec., May 13, 1903, VW.

Genus ***Maniola*** SCHRANK 1801
(syn. *Epinephele* [HÜBNER 1819])

128. ***Maniola jurtina jurtina*** LINNAEUS 1758
Material examined: 1 spec., June 17, 1923; 4 specs., July 9, 1907; July 14, 1903; May 15, 1903, VW.

Genus ***Aphantopus*** WALLENGREN 1853

129. ***Aphantopus hyperanthus hyperanthus*** LINNAEUS, 1758
Material examined: 4 specs., July 9, 1907; July 14, 1904, VW.

Genus ***Coenonympha*** HÜBNER [1819]
(syn. *Chortobius* DUNNING & PICKARD 1858; *Sicca* VERITY 1953)

130. ***Coenonympha pamphilus pamphilus*** LINNAEUS 1758
Material examined: 2 specs., May 12, 1904; May 29, 1903, VW.

131. ***Coenonympha arcania arcania*** LINNAEUS 1761 (syn. *C. amyntas* PODA 1761) 3 specs., July 15, May 15, 1903; July 9, 19, 1907; 2 specs., May 14, 1904, VW.

132. ***Coenonympha glycerion glycerion*** BORKHAUSEN 1788 (syn. *C. iphis* DENIS & SCHIFFERMÜLLER 1775, invalid homonim)
Material examined: 5 specs., June 24, 1938; July 16, 1948; June 10, 17, 1923; May 22, 1945; May 25,1939; September 18, 1953, VW.

Family LYCAENIDAE

Subfamily Riodininae

Genus ***Hameris*** HÜBNER [1819]
(syn. *Nemeobius* STEPHENS 1827)

133. ***Hameris lucina lucina*** LINNAEUS 1758
Material examined: 5 specs., April 1920 (no collection day); May 12, 1904 VW; July 26, 1904, VW.

Subfamily Theclinae

Genus ***Thecla*** FABRICIUS 1807
(syn. *Ruralis* TUTT [1906]; *Zephyrus* DALMAN 1816; *Quercusia* VERITY 1943; *Aurotis* KIRBY 1862, nec. DALMAN 1816)

134. ***Thecla quercus quercus*** LINNAEUS 1758
Material examined: 1 spec., June 9, 1907; 1 spec., July 9, 1907; 2 specs., July 4, 1904; 2 specs., May 8, 1954, VW.

Genus ***Nordmannia*** TUTT [1907]
(syn. *Necovatia* VERITY 1951)

135. ***Nordmannia acaciae nostras*** COURVOISIER 1913
Material examined: 1 spec., July 9, 1904, VW.

Genus ***Strymonidia*** TUTT 1908

136. ***Strymonidia pruni*** LINNAEUS 1758
Material examined: 1 spec., July 9, 1904, VW.

137. ***Strymonidia spini spini*** DENIS & SCHIFFERMÜLLER 1775
Material examined: 1 spec., June 10, 1923, VW.

Genus ***Callophrys*** BILLBERG 1820

138. ***Callophrys rubi*** LINNAEUS 1758
Material examined: 1 spec., June 26, 1904, VW.

Subfamily Lycaeninae

Genus ***Lycaena*** FABRICIUS 1807
(syn. *Heodes* DALMAN 1816; *Chrysophanus* HÜBNER 1816, *Palaeochrysophanus* VERITY 1943;)

139. ***Lycaena phlaeas*** LINNAEUS 1761
Material examined: 2 specs., July 14, 1903; May 21, 1904, VW.

140. ***Lycaena virgaureae virgaureae*** LINNAEUS 1758
Material examined: 1 spec., June 10, 1923, VW.

141. ***Lycaena tityrus*** PODA 1761
Material examined: 3 specs., May 21, 1903, 1 spec., May 1, 1903, VW.

Subfamily Plebejinae

Genus ***Polyommatus*** LATREILLE 1804

142. ***Polyommatus icarus icarus*** ROTTEMBURG 1775
Material examined: 1 spec., May 21, 1904; 2 specs., June 19, 1907, VW.

CONCLUSIONS

Macrolepidoptera data processing and their centralization in the form of a systematic list of species collected in the forest perimeter was the purpose of this paper. This paper updates the state of knowledge of this group of insects around Sibiu; it is thus aimed at achieving a "Red List" of the endangered and extinct species in the forest area of Sibiu Grove. It also, adds new data on these Macrolepidoptera species around Sibiu.

Most species of the Viktor Weindell's collection were gathered from the forest area and they belong to the families Noctuidae (178) Geometridae (170), Nymphalidae (38) and Satyridae (22). The largest number of specimens belonging to the families: Geometridae (773), Noctuidae (634), Nymphalidae (420), Lycaenidae (393) Satyridae (359), Pieridae (307) Hesperiidae (117), Arctiidae (117).

The conservation of diversity of the Sibiu Forest Grove butterflies should take into account the requirements of priority butterfly species, but it is impossible to propose uniform management for all of them. However, although ecological succession is the main problem, except for some cases where quick action is needed, all intensifications should be done very carefully. Single mowing of the whole habitat with heavy machines in the sensitive period of their life cycle can be much more destructive than abandonment for years.

ACKNOWLEDGEMENTS

This research is supported by the European Social Fund, through the Human Resources Development Operational Programme 2007-2013, the project POSDRU/89/1.5/S/63258 Postdoc School for Zootechnical Biodiversity and Food Biotechnology based on Ecoeconomy and Bioeconomy Required by Ecosanogenesis.

REFERENCES

KOCH M. 1991. *Wir bestimmen Schmetterlinge.* Edit. Neumann Verlag Radebeul. 347 pp.

PASCU MARIANA & SCHNEIDER ECKBERT. 1998. *Colecţii entomologice ale Muzeului de Ştiinţe Naturale din Sibiu.* Studii şi comunicări. Ştiinţe Naturale. Edit. Imago. Sibiu. **27**(1). 218 pp.

POPESCU-GORJ A. 1970. *Hundert Jahre Schmetterlingsfrorschungen im Rahmen des Siebenburgischen Vereins fur Naturwissenschaften.* Studii şi comunicări. Ştiinţele Naturii. Edit. Muzeului Brukenthal Sibiu. **15**(91): 96.

POPESCU-GORJ A. 1980. *Actualizarea clasificării şi nomenclaturii speciilor de Macrolepidoptere din fauna României.* CUMIDAVA. Ştiinţele Naturii. **12**(4): 101-149.

RÁKOSY L. GOIA M., KOVACV Z. 2003. *Catalogul lepidopterelor României.* Societatea Lepidopterologică Română. Cluj-Napoca. 446 pp.

SCHNEIDER ECKBERT. 1984. *Die Gross-Schmetterlinge der Sammlung Dr. V. Weidell. Ein Beitrag zur Faunistik der Lepidopteren Südsiebenbürgens und angrenzender Gebiete.* Studii şi comunicări. Ştiinţele Naturii. Muzeul Brukenthal. Sibiu. **26**: 289-316.

STANCĂ-MOISE CRISTINA. 2001. *The entomologists from Sibiu their contribution to the knowledge of the Lepidopterofauna of Sibiu-Surroundings colections, Lepidoptera, Macrolepidoptera.* Sesiunea Ştiinţifică dedicată împilinirii a 75 de ani de la înfiinţarea Staţiunii Biologice Marine „Prof. Dr. Ioan Borcea" Agigea-Constanţa, 19-20 octombrie 2001. Sectiunea Biologie animală. **48**. 711 pp.

STANCĂ-MOISE CRISTINA. 2003. *Structura şi dinamica Macrolepidopterelor din Complexul Natural Dumbrava Sibiului.* Lucrările celei de a 6-a Conferinţe Naţionale pentru Protecţia Mediului prin Metode şi Mijloace Biologice şi Biotehnice şi a Celei de a 3-a Conferinţe Naţionale de Ecosanogeneză, 31 Mai 2003, Braşov: 293-301.

STANCĂ-MOISE CRISTINA. 2004. *Importanţa Macrolepidopterelor în cadrul ecosistemului Pădurii de stejar „Dumbrava Sibiului".* Oltenia. Studii şi comunicări. Ştiinţele Naturii. Muzeul Olteniei Craiova. **20**: 219-222.

MOISE CRISTINA. 2002. *Contribuţii la studiul structurii si activităţii Macrolepidopterelor din Complexul Natural Dumbrava Sibiului şi reflectarea presiunii antropice asupra acestora.* Universitatea Bucureşti. 258 pp.

Stancă-Moise Cristina
"Lucian Blaga" University of Sibiu,
Progresului Str., No. 22, Sibiu, Romania
E-mail: cristinamoise1@yahoo.com

Received: March 31, 2011
Accepted: August 28, 2011

GENETIC ANALYSIS IN *Drosophila melanogaster* NATURAL POPULATIONS COLLECTED FROM DIFFERENT ECOSYSTEMS SUBJECTED TO ABIOTIC STRESS

CHELU Cristina, CORNEANU Mihaela, BUTNARU Gallia

Abstract. We used Random amplified polymorphic DNA (RAPD) to analyze DNA polymorphisms for 9 *Drosophila melanogaster* populations collected from salty soils, radioactivity and arid zones from Romania. In this study we used 10 RAPD primers (10 bp) in order to determine genetic distance between our collected populations from different ecosystems. Using Unweighted Pair Group Method with Arithmetic Mean (UPGMA) we obtained a phylogenetic tree which divided our *D. melanogaster* populations in two groups related to the specific area collection. *D. melanogaster* Socodor has proved to be the oldest, being grouped with the wild type, Oregon. We found two unique bands in *D. melanogaster* Peşteana and Plopşoru populations, both of them were collected from mining areas. The genetic distance is small between *D. melanogaster* populations according with the phenotype traits and life span.

Keywords: *Drosophila melanogaster*, populations, RAPD, genetic distance, phylogenetic tree.

Rezumat. Analize genetice la populaţiile naturale de *Drosophila melanogaster* colectate din diferite ecosisteme supuse stresului abiotic. Pentru analiza ADN-ului polimorfic la 9 populaţii de *Drosophila melanogaster* colectate de pe soluri de sărătură, radioactivitate şi zone aride din România s-a utilizat metoda amplificării ADN-ului polimorfic la întâmplare (RAPD). În acest studiu s-au utilizat 10 primeri (10 pb) pentru determinarea distanţei genetice dintre populaţiile colectate din diferite ecosisteme. Prin metoda UPGMA s-a obţinut un arbore filogenetic care împarte populaţiile de *D. melanogaster* în 2 grupe în conformitate cu specificul locului de colectare. *D. melanogaster* Socodor s-a dovedit a fi cea mai veche, fiind grupată cu tipul sălbatic, Oregon. S-au observat 2 benzi unice la populaţiile *D. melanogaster* Peşteana şi Plopşoru, ambele au fost colectate din zone cu activitate minieră. Distanţa genetică dintre populaţiile de *D. melanogaster* este mică, conform cu caracterele fenotipice şi ciclul de viaţă.

Cuvinte cheie: *Drosophila melanogaster,* populaţii, RAPD, distanţă genetică, arbore filogenetic.

INTRODUCTION

Natural populations are constantly exposed to challenging environments and it is necessary for the organism to buffer this environmental variation to maintain the cellular homeostasis and high performance across environmental. The stress response and heat shock proteins are important for this buffering in relation to stress resistance and adaptation to the environment under some conditions (SORENSEN et al., 2003). All organisms are strongly affected by their surrounding environment, and the environmental factors play an important part in shaping ecology and evolution of biological systems. Environmental stress is especially important at many levels of biological organization (HOFFMANN & PARSONS, 1997; HOFFMANN & HERCUS, 2000). In this context environmental stress is regarded as an "environmental factor causing a change in a biological system, which is potentially injurious" (HOFFMANN & PARSONS, 1991) and which has some fitness consequences (BIJLSMA & LOESCHCKE, 1997). Spatial and temporal variations, which predominate in nature, is of prime importance in maintaining genetic diversity in natural populations. This ecological genetic pattern is true, because different genotypes display varying fitness in variable environments and stresses. Recombination frequencies and mutation rates tend to increase under stressful conditions (HOFFMANN & PARSONS, 1991; KOROL, 1999). Changes in vegetation also lead to changes in the local microclimate. The variation in the actual local temperatures is even higher than that of the air temperatures as recorded by standard measurement techniques. Vegetation that is more open causes higher light intensity on the ground. Both temperature and openness affect humidity and the air is near saturation throughout the day in closed-canopy forest but fluctuates greatly in more open vegetation (WALTER, 1984 cit. VAN DER LINDE & SEVENSTER, 2006). The effect of temperature has been studied in different species of *Drosophila* on both adult and preadult characters. Interspecific competitions of larvae have shown to be influenced by temperature in *Drosophila* (FOGLEMAN & WALLACE, 1980; BUDNIK & BRNCIC, 1983; RICCI & BUDNIK, 1984). A combination of genomics, proteomics and metabolomics will further elucidate the effects of stress on expression patterns at the DNA, RNA and protein levels and the effect on metabolism (LOESCHCKE et al., 2004; MALMENDAL et al., 2006).

The aim of the present study was to determine phenotypic and molecular polymorphism among several *Drosophila melanogaster* natural populations collected from salty soils, mining areas and aridity zones from Romania.

MATERIAL AND METHODS

***Drosophila melanogaster* populations.** In our study we used 9 populations of *Drosophila melanogaster* which were collected from different areas of Romania, including polluted zones as it follows: Socodor (solonchaks and steppe vegetations, plain area), Tg-Jiu, Peşteana, Plopşoru and Turceni (submountain hilly area, mines activity), Bucovăţ (forest, natural radioactivity), Giubega and Moţăţei (sand dunes and arid zones, plain area), Şag (unspecific pollution) and as control we used the wild type, Oregon. The name of our population comes from the collection areas. Collection was done using traps in areas of interest on shaded places, in the morning. Traps were made by glass jars with perforated cover and the attractant was represented by fermented fruit, especially bananas and the trap was collected in

the evening. During the analyses, the populations of *Drosophila melanogaster* were maintained in laboratory conditions (25 °C) using a corn-meal, yeast and sugar medium. The experiment was conducted in two repetitions, at 25°C. We used adult individual, 1-4 days old, sex-ratio 1:1. Observations were made for 28 days until the last individuals hatched out.

DNA extraction. We chose randomly 20 flies from each populations and we isolated DNA by rapid and small isolation method after Steller protocol (cit. by RUBIN, 1990). The concentration of extracted DNA was measured at spectrophotometer and the purity was calculated by ratio of absorbance at 260 nm and that of 280 nm. The isolated DNA was diluted at 50 ng/µl.

RAPD analysis. In order to establish genetic polymorphism among our collected populations of *Drosophila melanogaster* we used random amplified polymorphic DNA (RAPD) technique, based on DNA markers. In RAPD reactions we used 10 ologonucleotide primers (Biosearch Techologies) with sequences: P1 5'(TGC-GGG-AGT-G)3', P3 5' (AAG-AGC-CCT-A)3', P4 5'9GGC-TTG-GCG-A)3', P5 5'(CAC-TGG-CCC-A)3', P7 5'(TGG-TCG-GGT-G)3', P8 5'(CTA-AGC-GCA)3', P9 5'(TTG-CTG-GGC-G)'3, P11 5'(CCG-CTG-GAG-C)3', P15 5'(GCT-CCC-CCA-C)3', P16 5'(TTG-CTG-GGC-G)3'. PCR mixture was performed in a 25 µl final volume, containing the following components: 50 ng/µl DNA, 1.5 unit of Taq DNA Polymerase (Fermentas), Dream Taq Buffer (Fermentas), 25 mM $MgCl_2$ (Fermentas), 25 mM dNTPs (Fermentas), 10 µM primer and H_2O distilled water until final volume. PCR reactions were run in a DNA Thermocyler (Biorad) using the next program: 3 min denaturation at 94°C, followed by 36 cycles of 1 min at 94°C, 1 min at 36°C, extension was done at 72°C for 2 min and final extension at 72°C for 7 min. The PCR products were migrated in agarose gel (1.2%) by electrophoresis in TBE buffer (5X), separating them according to their molecular weight. Amplified DNA fragments were stained with ethidium bromide and visualization of DNA bands and photography was done with UV Vilber Lourmat. Images (photos) obtained were processed in Microsoft Office Power Point.

Data analysis. The present bands on the agarose gel were scored with 1 and the absence was noted with 0. We take into account only the bands well reproduced in both repetitions in order to obtain a binary matrix. The genetic similarity was calculated based on Jaccard's coefficient. The complement of Jaccard similarity coefficient represents the genetic distance between the populations of *D. melanogaster*, based on these results it has been achieved the matrix of distance. The data obtained was used to construct a dendrogram based on UPGMA algorithm (Unweighted Pair Group Method of Arithmetical Averages) by SAITOU & NEI (1987). Statistical analysis regarding body size were performed by measuring 5 female, 5 males and also 5 larvae and 5 pupae form each population. For the life cycle and sex ratio we counted the emerging flies every day. We also noticed the number of non emerged individuals in pupa stage of development.

RESULTS AND DISCUSSION

Morphological description of *Drosophila melanogaster* populations. In our study we used 9 natural populations of *Drosophila melanogaster* collected from different polluted areas and standard type, Oregon, for control. After collection we have analyzed the phenotype of each population regarding eye color, number of abdominal segments, abdomen and wing shape (Fig. 1). There was no major difference between collected populations of *Drosophila melanogaster*.

Adult. Our collected populations from different ecosystems have red eyes, with no differences compared with the standard type Oregon. The body is yellow in natural populations of *D. melanogaster*, and black striped abdomen, slightly on females, and round on males, the last segment being black. Our populations of *D. melanogaster* are characterized by body size (Fig. 1) between 0.31±0.00 and 0.34±0.01 cm for females and 0.26±0.01 to 0.30±0.00 cm among males.

Intra-population variability of body size is small, gently is detaching *D. melanogaster* Plopşoru population, followed by *D. melanogaster* Moţăţei in case of females and in males the population *D. melanogaster* Peşteana followed by Bucovăţ, Turceni and Plopşoru populations. Compared with the wild type Oregon (0.34±0.00 cm) females, the body size of the populations of *D. melanogaster* Târgu-Jiu and Plopşoru presents low values like 0.31 cm and 0.32 cm. Regarding body size in males, only populations of *D. melanogaster* Socodor and Şag have the same average of value (0.30±0.00 cm), in the other populations individuals being smaller, with the average sizes ranging up to 0.26±0.01 cm in *D. melanogaster* Bucovăţ population.

By the transparency of the abdomen we observed that the ovaries are white and testes are yellow (Fig. 2), sexual dimorphism in *Drosophila melanogaster* being well defined. Our natural populations of *D. melanogaster* have normal wings (Fig. 3) as the control (Oregon). The form differs slightly from population to population.

Larva. The color of larva is white in all *Drosophila melanogaster* collected populations (Fig. 4). Regarding larvae dimensions, the highest value (0.48±0.01 cm) was determined for *D. melanogaster* Turceni population and the lowest intra-populational variability when was compared with wild type, Oregon which showed the highest variability of the larvae size with an average of 0.38±0.02 cm. Larvae with the smallest dimensions belong to *D. melanogaster* Bucovăţ population (0.37±0.01 cm). *D. melanogaster* Sag population presents a medium variability which results from a non-specific environmental pollution. Inter-populational variability is small, as the obtained percentage was 7.37%.

Pupa. Pupa color is yellow-brown in *D. melanogaster* populations and slightly red in *D. melanogaster* Giubega and Bucovăţ. The size of pupae (Fig. 4) varies from 0.30±0.00 cm in *Drosophila melanogaster* Socodor and Plopşoru populations and Oregon, to 0.34±0.02 cm in *D. melanogaster* Giubega. The highest intra-populational variability in pupa stage was determined for *D. melanogaster* Giubega population and the lowest for Oregon.

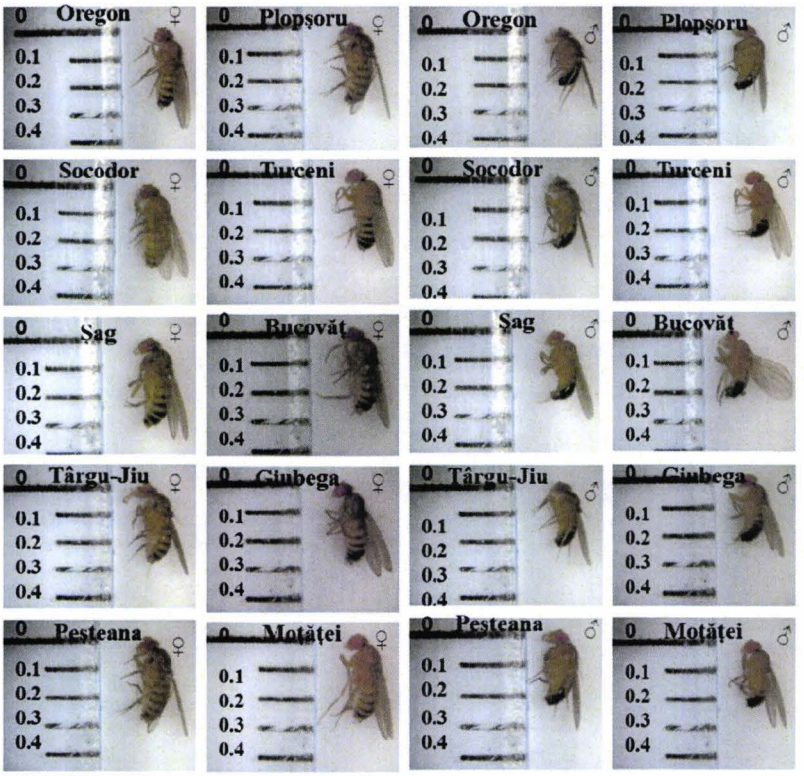


Figure 1. Morphological traits in natural populations of *D. melanogaster*, in the left panel we presented females and males in the right panel (original).
Figura 1. Caracterele morfologice la populaţiile naturale de *D. melanogaster*, în panelul din stânga sunt prezentate femelele şi masculii în panelul din dreapta (original).

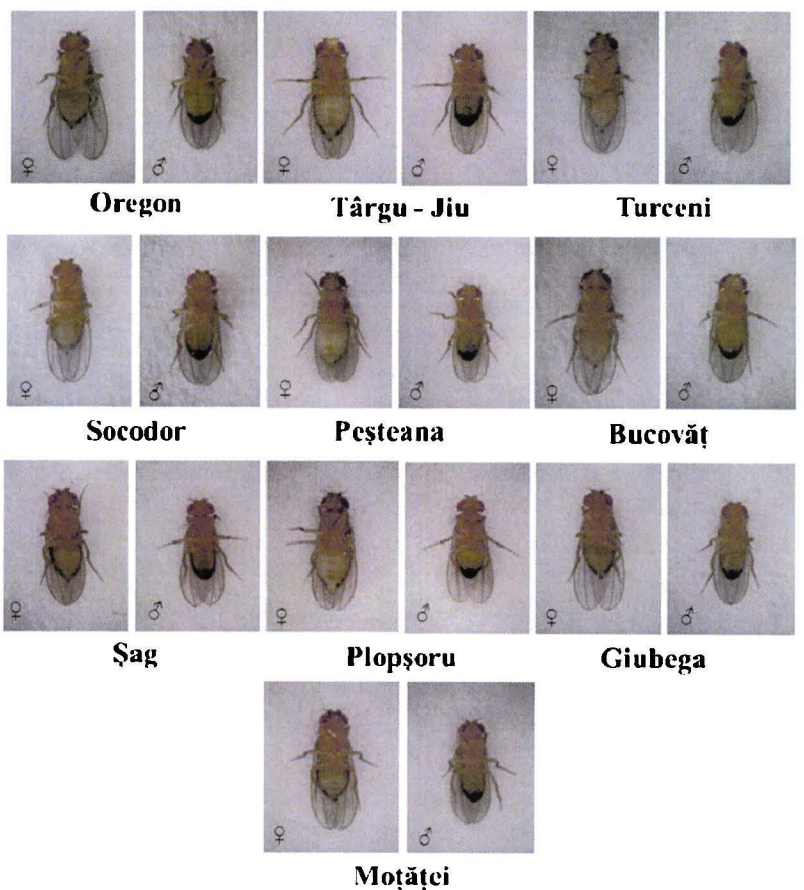


Figure 2. Ventral part of the body in *D. melanogaster* natural populations (original).
Figura 2. Partea ventrală a corpului la populaţiile naturale de *D. melanogaster* (original).

Table 1. Phenotypic characters (body size in females and males, larva and pupa size) in *Drosophila melanogaster* natural populations. / Tabel 1. Caracterele fenotipice (dimensiunea corpului la femele şi masculi, dimensiunea larvei şi a pupei) la populaţiile naturale de *Drosophila melanogaster*.

Population	Statistical parameters															
	Body size ♀				Body size ♂				Larva size				Pupa size			
	$x \pm s_x$	s^2	s%	s	$x \pm s_x$	s^2	s%	s	$x \pm s_x$	s^2	s%	s	$x \pm s_x$	s^2	s%	s
Oregon	0.34±0.00	0.00	2.33	0.01	0.30±0.00	0.00	1.43	0.00	0.38±0.02	0.00	13.94	0.05	0.30±0.00	0.00	1.34	0.00
Socodor	0.35±0.01	0.00	3.31	0.01	0.30±0.00	0.00	2.48	0.01	0.43±0.01	0.00	4.94	0.02	0.30±0.00	0.00	1.66	0.00
Şag	0.36±0.00	0.00	1.76	0.01	0.30±0.00	0.00	2.11	0.01	0.42±0.02	0.00	11.66	0.05	0.33±0.01	0.00	8.14	0.03
Tg-Jiu	0.31±0.00	0.00	2.61	0.01	0.29±0.00	0.00	1.37	0.00	0.45±0.02	0.00	8.10	0.04	0.31±0.00	0.00	3.18	0.01
Peşteana	0.34±0.00	0.00	2.19	0.01	0.28±0.01	0.00	9.86	0.03	0.45±0.01	0.00	7.05	0.03	0.31±0.00	0.00	3.53	0.01
Plopşoru	0.32±0.01	0.00	7.19	0.01	0.28±0.01	0.00	6.10	0.02	0.42±0.01	0.00	5.49	0.02	0.30±0.00	0.00	2.51	0.01
Turceni	0.34±0.00	0.00	2.86	0.02	0.28±0.01	0.00	6.10	0.02	0.48±0.01	0.00	4.72	0.02	0.32±0.01	0.00	5.87	0.02
Bucovăţ	0.34±0.01	0.00	3.57	0.01	0.26±0.01	0.00	6.81	0.02	0.37±0.01	0.00	8.39	0.03	0.31±0.01	0.00	6.21	0.02
Giubega	0.34±0.01	0.00	3.57	0.01	0.28±0.01	0.00	5.42	0.01	0.45±0.01	0.00	5.78	0.03	0.34±0.02	0.00	13.02	0.04
Moţăţei	0.33±0.01	0.00	4.98	0.02	0.28±0.00	0.00	1.72	0.00	0.43±0.01	0.00	5.30	0.02	0.32±0.01	0.00	5.34	0.02
$x \pm s_x$	0.34±0.01				0.29±0.00				0.43±0.01				0.31±0.01			
s^2	0.00				0.00				0.00				0.00			
s%	3.99				4.23				7.37				4.08			
s	0.00				0.04				0.03				0.05			

Table 2. Larva motility (cm) in *D. melanogaster* natural populations. / Tabel 2. Motilitatea larvei (cm) la populaţiile naturale de *D. melanogaster*.

Statistical parameters	Oregon	Socodor	Şag	Tg - Jiu	Peşteana	Plopşoru	Turceni	Bucovăţ	Giubega	Moţăţei
$x \pm s_x$	2.85±0.04	3.05±0.46	3.30±0.00	2.10±0.07	3.90±0.14	1.80±0.50	2.60±0.43	3.20±0.57	3.25±0.04	2.60±0.43
s^2	0.00	0.42	0.00	0.01	0.04	0.49	0.36	0.64	0.00	0.36
s%	1.75	21.31	0.00	4.76	5.13	38.89	23.08	25.00	1.54	23.08
S	0.05	0.65	0.00	0.10	0.20	0.70	0.60	0.80	0.05	0.60

Table 3. Pupa mortality in *D. melanogaster* natural populations. / Tabel 3.Mortalitatea pupelor la populaţiile naturale de *D. melanogaster*.

Statistical parameters	Oregon	Socodor	Şag	Tg - Jiu	Peşteana	Plopşoru	Turceni	Bucovăţ	Giubega	Moţăţei
$x \pm s_x$	15.00±9.22	1.50±1.06	0.00±0.00	8.00±0.71	1.50±0.35	2.00±0.71	5.50±3.90	4.50±1.06	3.00±0.00	6.50±1.77
s^2	169.00	2.25	0.00	1.00	0.25	1.00	30.25	2.25	0.00	6.25
s%	86.67	100.00	-	12.50	33.33	50.00	100.00	33.33	0.00	38.46
S	13.00	1.50	0.00	1.00	0.50	1.00	5.50	1.50	0.00	2.50

Table 4. Livestock (average of 2 repetitions) in *D. melanogaster* natural populations. / Tabel 4. Prolificitatea (media a 2 repetiţii) la popuaţiile naturale de *D.melanogaster*.

Population	Oregon	Socodor	Şag	Tg - Jiu	Peşteana	Plopşoru	Turceni	Bucovăţ	Giubega	Moţăţei
	116.00±39.72	145.00±29.79	131.50±93.26	146.50±2.48	245.50±21.63	33.00±17.73	131.50±14.54	153.50±58.51	200.00±3.55	80.50±2.48

Table 5. Sex-ratio (♀: ♂) in *D. melanogaster* natural populations. / Tabel 5. Sex-raţio (♀: ♂) la populaţiile naturale de *D. melanogaster*.

Sex-ratio ♀: ♂	Oregon	Socodor	Şag	Tg - Jiu	Peşteana	Plopşoru	Turceni	Bucovăţ	Giubega	Moţăţei
	1.06:0.94	0.98:1.02	0.96:1.04	0.98:1.02	0.99:1.01	0.90:1.10	0.99:1.01	0.88:1.12	0.97:1.03	1.04:0.96

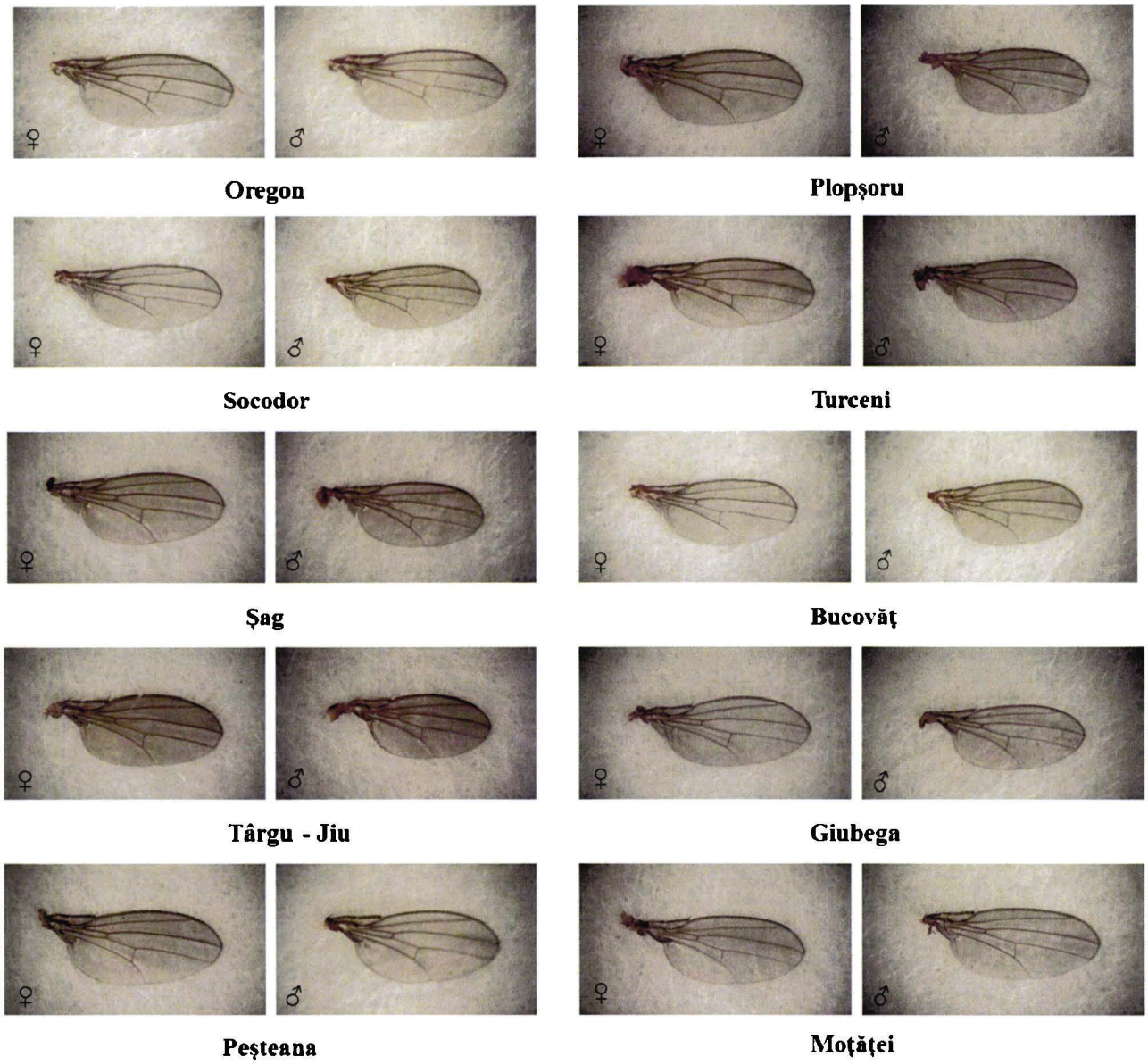


Figure 3. Wings shape in *Drosophila melanogaster* natural populations collected from salty soils, mining and arid areas (original).
Figura 3. Forma aripii la populaţiile naturale de *Drosophila melanogaster* colectate de pe soluri sărăturate, zone cu activitate minieră şi ariditate (original).

Life cycle in *Drosophila melanogaster* populations. *Drosophila melanogaster* is a small insect with complete metamorphosis including all steps of development: egg, larva, pupa and imago (adult). Physical and chemical factors can influence the development of insects. Temperature, salt contained in soils or the presence of certain chemical elements represent factors included in the categories listed above which leads to changes in *Drosophila* life cycle. In Fig. 5 it is presented the life cycle of the *D.melanogaster* populations collected (average of two repetitions). Life cycle average was 9.90±0.09 days, and in case of *D. melanogaster* Plopşoru the imago stage occurs after 9 days. In wild type, Oregon, the life cycle takes 10 days.

The life span in *Drosophila melanogaster* populations collected from mining and arid areas had 10 days. We observed also the motility of larvae (Table 2). The lowest level was obtained for *D. melanogaster* Plopşoru (1.80 ± 0.50), close followed by *D. melanogaster* Târgu-Jiu population (2.10 ± 0.07). The best mobility was seen for the *D.melanogaster* Peşteana population (3.90 ± 0.14). All of these three populations were collected from closely areas, and were characterized by mining pollution.

In terms of prolificacy (Table 4), *D. melanogaster* Peşteana has proved to be the most prolific population (245.50±21.63 individuals) and had the lowest mortality (1.50 ± 0.35). This is followed by *D. melanogaster* Giubega population (200.00±3.55 individuals) and respectively *D. melanogaster* Tg-Jiu and Socodor with 146.50±2.48 and 145.00±29.79 individuals. The population with the lowest prolificacy was *D. melanogaster* Plopşoru (33.00±17.73 individuals).

The lowest level of mortality (Table 2) was observed in the case of *D. melanogaster* Şag population (0.00 ± 0.00) compared with the wild type for which was found the highest mortality (15.00 ± 9.22). Calculating sex-ratio (Table 5), we obtained a report easily dominated by males, except *D. melanogaster* Moţăţei population and the wild type.

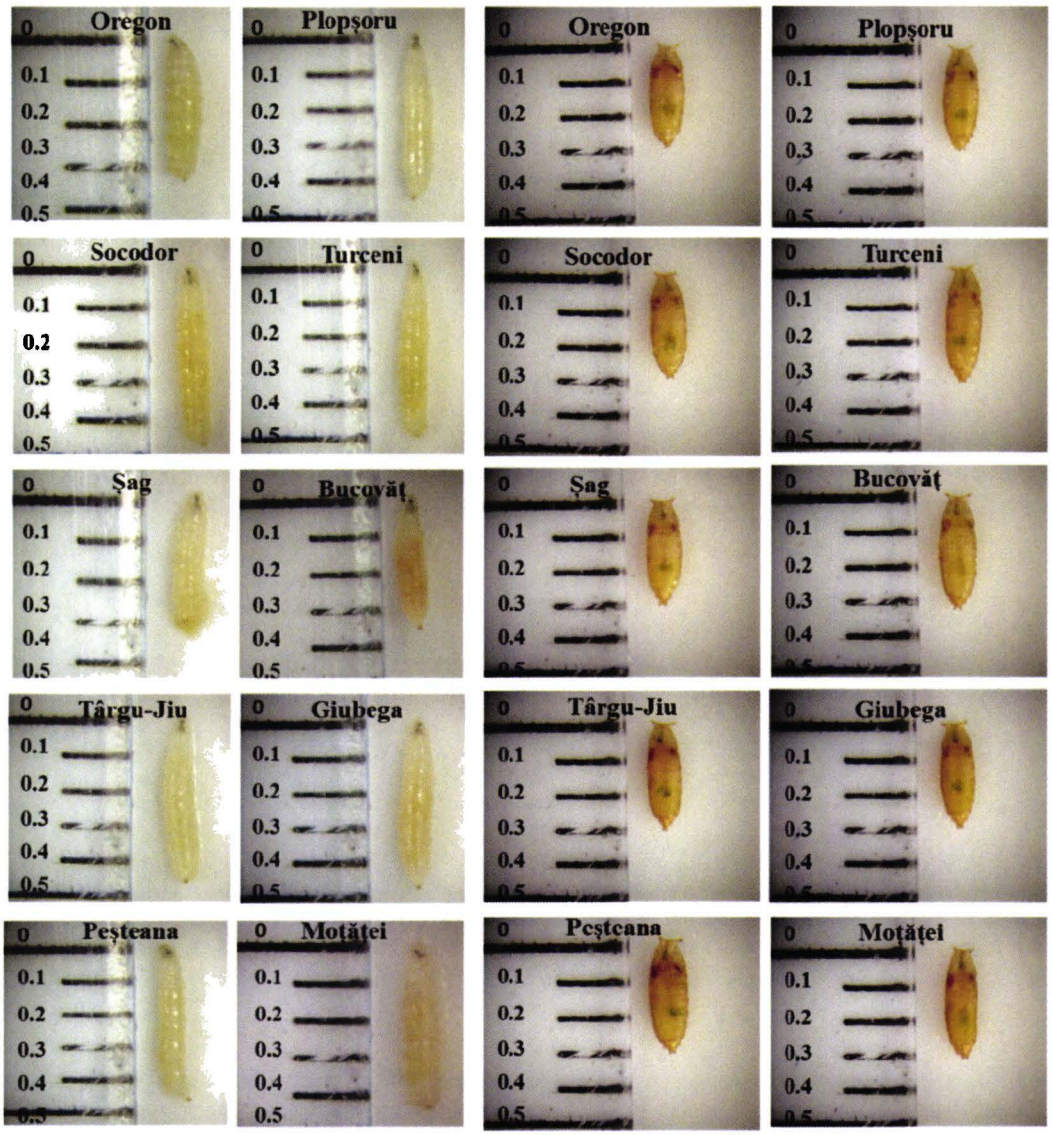


Figure 4. Larva and pupa traits in *Drosophila melanogaster* natural populations (original).
Figura 4. Caracteristicile larvei şi pupei la populaţiile naturale de *Drosophila melanogaster* (original).

Molecular polymorphisms in *Drosophila melanogaster* populations by RAPD technique

RAPD is a rapid and inexpensive method used in polymorphism determination and genetic analysis of populations. Analyses presented in this paper were carried out in two repetitions and we have considered only bands that have been faithfully reproduced in both repetitions with the same intensity in agarose gel (1.2%) for all populations. For each oligomer we calculated the total number of bands, constant number of bands (bands present in all genotypes) and variable number of bands (bands that are found only in some populations). In our study we used 10 primers, oligomer 11 with sequence 5'(CCG-CTG-GAG-C)3' gave no amplification in the second repetition and for this reason it was not taken into account. For the other 9 oligomers we obtained PCR products with molecular weight ranging from 4000 bp to100 bp.

The highest total number of bands was obtained for primer 16 (18 bands) and primer 8 gave only three bands, the average of bands was 10.66. Oligomer 3 with sequence 5'(AAG-AGC-CCT-A)3' generated the largest polymorphism, 80% , and the lowest polymorphism was observed in the oligomer 16, only 11%. Overall we obtained a polymorphism of 40.24% compared with the wild type (Oregon).

Unique bands were observed in the molecular profile of *Drosophila melanogaster* Plopşoru (Fig. 8) and Peşteana (Fig. 6) populations, both belonging to areas with mining activity. Also, the wild type, Oregon has a unique band with a weight of about 2100 bp, very close to the unique band seen in *D. melanogaster* Peşteana population (2150 bp). Based on

the 96 total number of bands was constructed the matrix distance, by calculating the Jaccard coefficient for each two pairs of the populations. Present bands (amplified) were scored by 1, and the absence by 0.

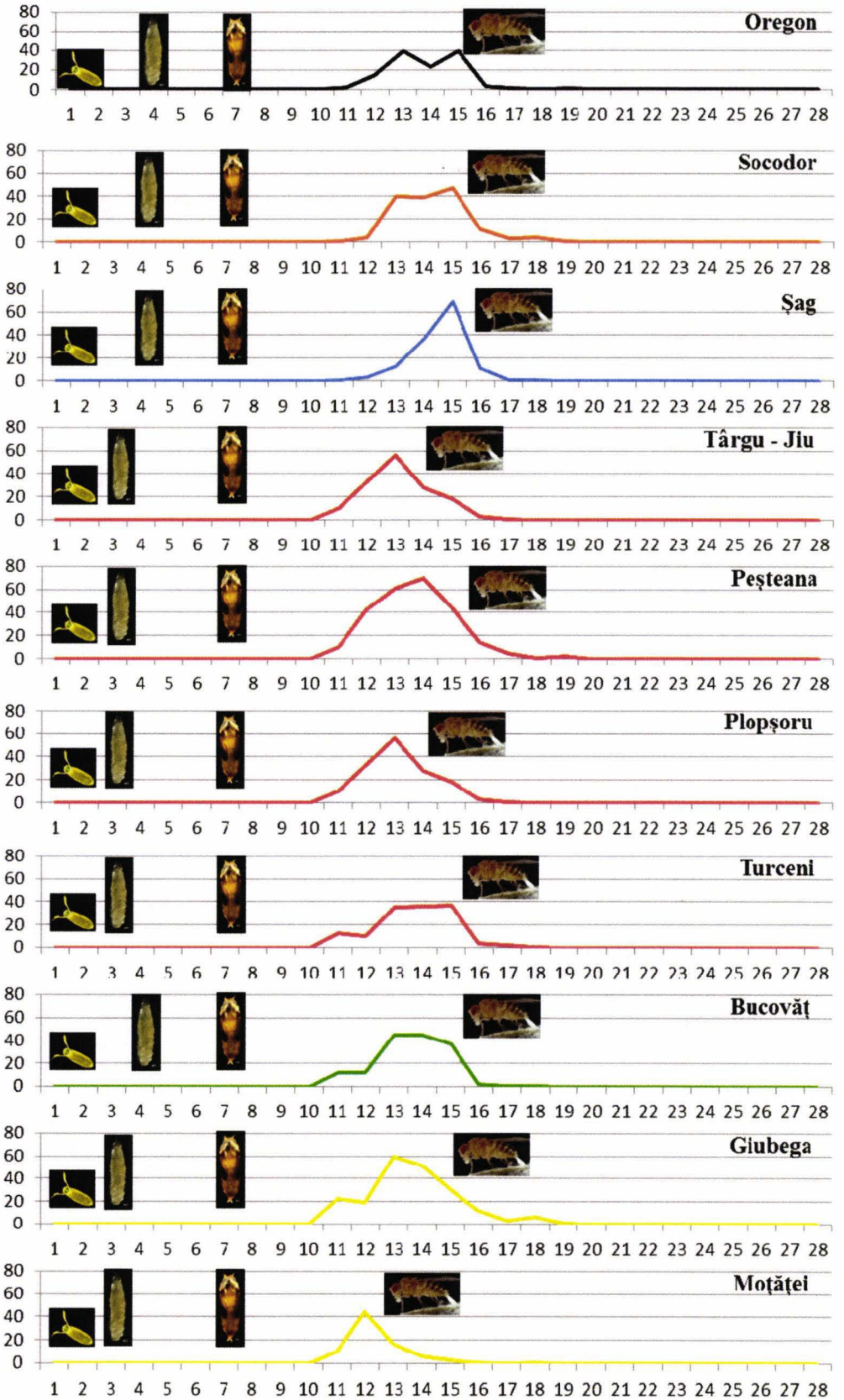


Figure 5. Life cycle in *D. melanogaster* natural populations collected from salty soils, mining areas and arid areas.
Figura 5. Ciclul de viaţă la populaţiile naturale de *D. melanogaster* colectate de pe soluri sărăturate, zone cu activitate minieră şi zone aride.

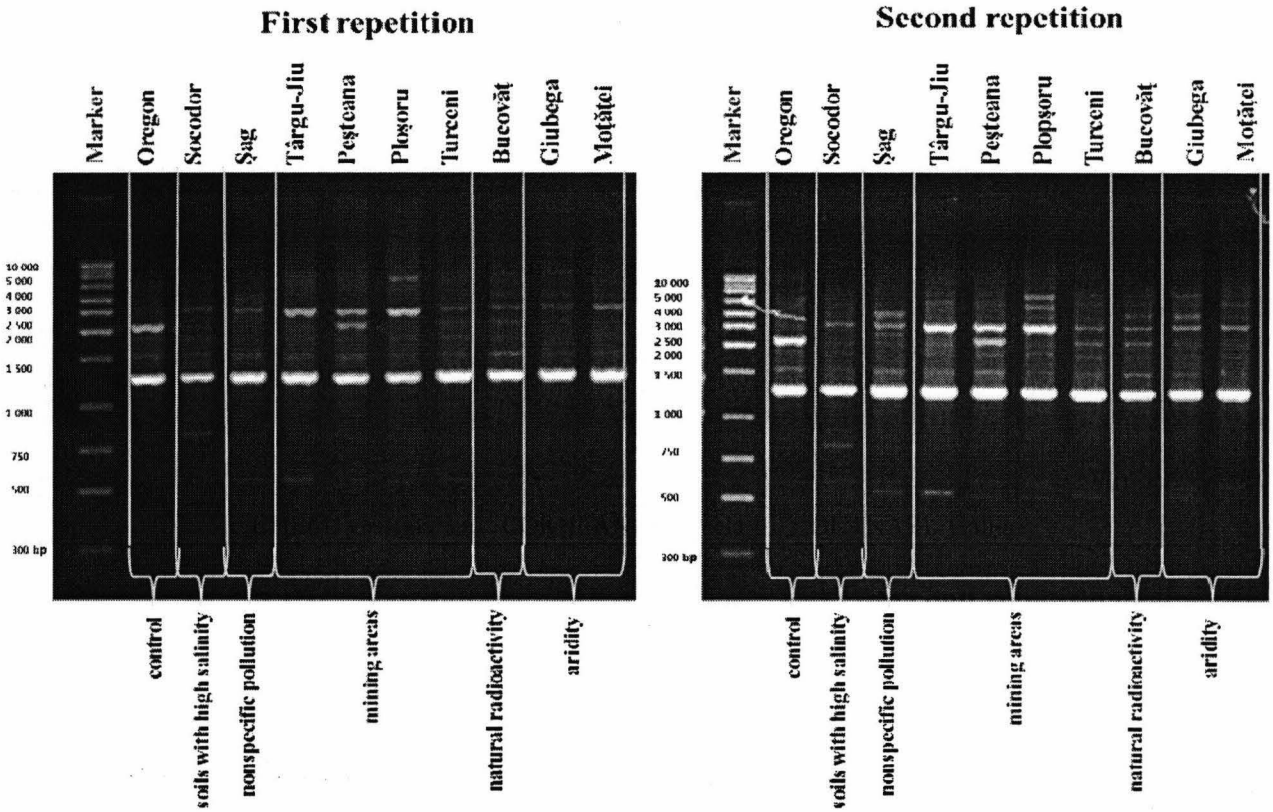


Figure 6. Molecular profile in *D. melanogaster* populations with primer P3 (red arrow - unique band).
Figura 6. Profilul molecular la populaţiile de *D. melanogaster* cu primerul P3 (săgeata roşie - bandă unică).

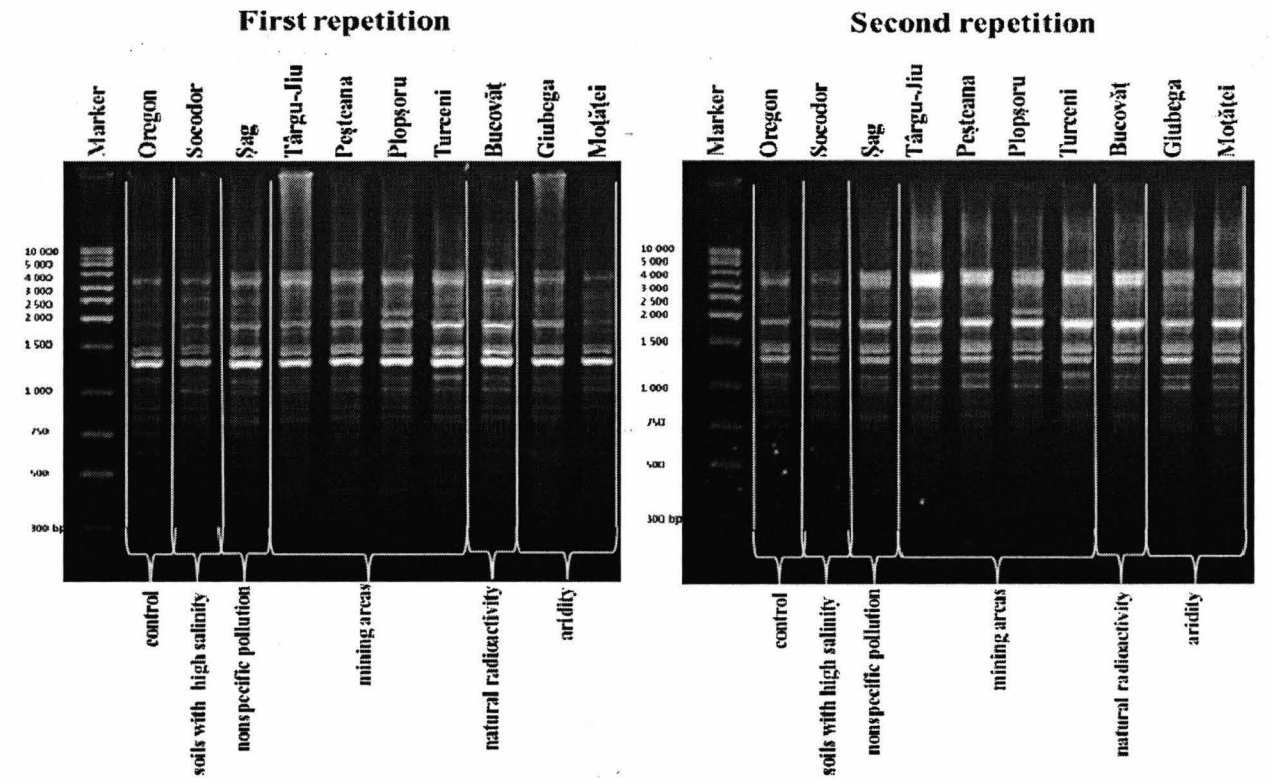


Figure 7. Molecular profile in *D. melanogaster* populations with primer P4 (red arrow - unique band).
Figura 7. Profilul molecular la populaţiile de *D. melanogaster* cu primerul P4 (săgeata roşie - bandă unică).

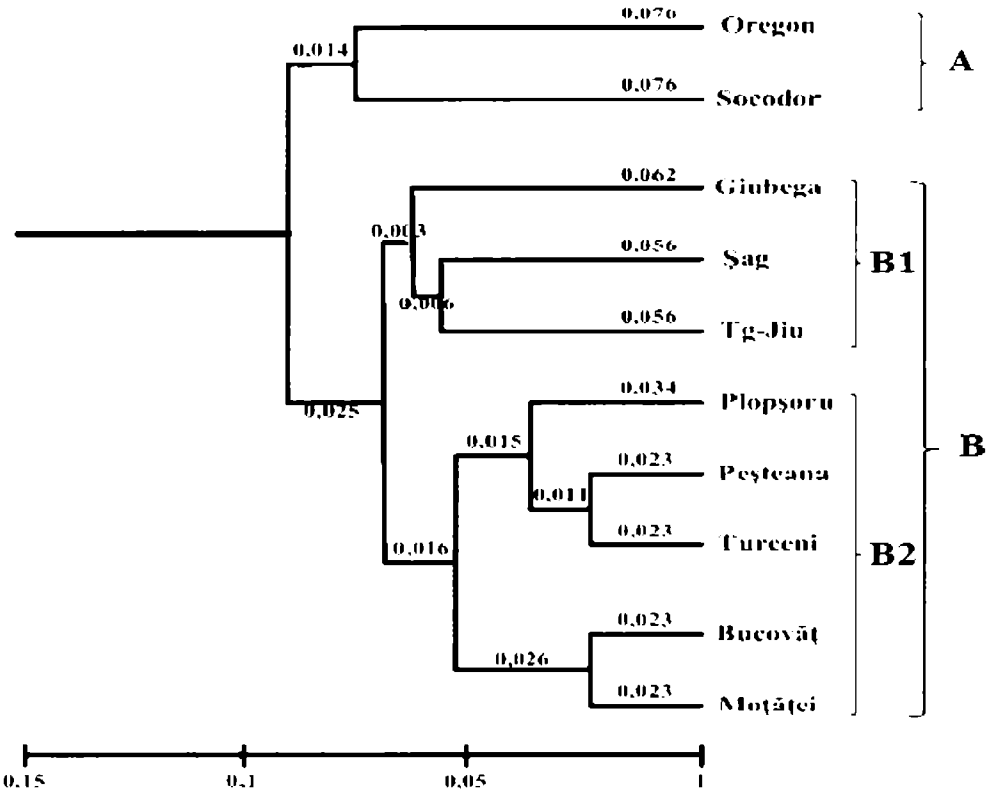


Figure 8. Dendrogram for *D. melanogaster* natural populations based on RAPD results.
Figura 8. Dendrograma pentru populaţiile naturale de *D. melanogaster* pe baza rezultatelor RAPD.

The dendrogram presented above shows two main groups, noted A and B. Group A contains wild type, Oregon and *D. melanogaster* Socodor. Group B is divided in two subgroups: one subgroup (B1) consists of *D. melanogaster* Giubega, Şag and Socodor populations and the second subgroup consists in the following populations of *D. melanogaster*: Plopşoru, Peşteana and Turceni, and respectively Bucovăţ and Moţăţei populations. In our comparative study between the wild type, Oregon, and the nine populations of *D. melanogaster* collected from different ecosystems we can notice that the nearest genetically populations are *D. melanogaster* Peşteana and Turceni populations and also *D. melanogaster* Bucovăţ and Moţăţei with the lowest genetic distance (0.023). Generally, genetic similarity values among populations were small. The root of the populations tree is positioned between this two groups, genetically group A being the oldest. The percentage of polymorphism obtained, 40.24%, shows a medium polymorphism, which can be explained by the fact that the flies could not be preserved immediately after collection.

Physiological acclimatization is a form phenotypic plasticity, by which an organism can adjust its metabolism in acute response in order to cope with the altered environmental conditions, for example, environmental stress, such as heavy metal toxicity or chemicals, and osmolarity changes. The ability to adapt to changing conditions will depend on both how well an individual can adjust to the new conditions (BAKKER et al., 2010; CANALE & HENRY, 2010; DE JONG et al., 2010). Secondary forest populations and the agricultural area populations of *Drosophila* have the shortest development time and the longest in grassland populations, and the forest edge populations were intermediate (VAN DER LINDE & SEVENSTER, 2006). In our previous studies we noticed the same adult size for *in situ Drosophila melanogaster* collected from Bucovăţ forest (CHELU et al., 2008). Geographical variation in traits related to fitness is often the results of adaptive evolution. Stress resistance traits in *Drosophila* show clinal variation, suggesting that selection affects resistance traits either directly or indirectly (SISODIA & SINGH, 2010).

CONCLUSIONS

Phenotypic variability is low in our populations of *Drosophila melanogaster* collected from different ecosystems subjected to abiotic stress. The average of development time in natural populations of *Drosophila melanogaster* was 10.50±0.26 days (at 25 °C). We emphasized in this study that *Drosophila melanogaster* Peşteana population had the best motility in larval stage (3.90±0.14), a low mortality in pupa stage (1.50±0.35) and proved to be the most prolific population. Mortality was significantly lower in natural populations compared with the wild type, Oregon, which demonstrate the ability of *Drosophila* to adapt at the environment conditions.

ACKNOLEDGEMENTS

This work was supported by POSDRU/6/1.5/S/21 and 52158/2008 PNII grants.

REFERENCES

BAKKER J., VAN RIJSWIKJ M., WEISSING F., BIJLSMA R. 2010. *Consequences of fragmentation for the ability to adapt to novel environment in experimental Drosophila metapopulations.* Conservation Genetics. Springer, Dordrecht. **11**(2): 435-448.

BIJLSMA R. & LOESCHCKE V. 1997. *Environmental stress, adaptation and evolution.* Basel. Birkhäuser Verlag: 11-15.

BUDNIK M. & BRNCIC D. 1983. *Preadult competition between colonizing population of Drosophila subobscura and established populations of Drosophila simulans in Chile.* Oecologia. Springer Verlag, Berlin. **58**: 137-140.

CANALE C. I. & HENRY P. Y. 2010. *Adaptive phenotypic plasticity and resilience of vertebrates to increasing climatic unpredictability.* Climate Research. Inter Research, Oldendorf. **43**: 135-147.

CHELU CRISTINA, POPESCU CRISTINA, BUTNARU GALLIA. 2008. *Essay to point out Drosophila melanogaster ecodiversity by RAPD markers.* Studia Universitatis Vasile Goldis. Arad. **18**(2): 83-87.

DE JONG M. A., KESBEKE F. M., BRAKEFIELD P. M., ZWAAN B. J. 2010. *Geographic variation in thermal plasticity of life history and wing pattern in Bicyclus anynana.* Climate Research. The Netherlands, Leiden. **43**: 91-102.

FOGLEMAN J. C. & WALLACE B. 1980. *Temperature-dependent development and competitive ability of three species of D. affinis group.* American Middle Naturalist. Jstor. **104**(2): 341-351.

HOFFMANN A. A. & PARSONS P. A. 1991. *Evolutionary genetics and environmental stress.* Oxford University Press. **9**. 283 pp.

HOFFMANN A. A. & PARSONS P. A. 1997. *Extreme environmental change and evolution.* Cambridge University Press. 259 pp.

HOFFMANN A. A. & HERCUS M. J. 2000. *Environmental stress as an evolutionary force.* Biosciences. BioOne, Washington. **50**: 217-226.

KOROL A. B. 1999. *Evolutionary Theory and Processes: Modern Perspectives.* The Netherlands. Wasser, Dordrecht: 31-53.

LOESCHCKE V., SORENSEN J. G., KRISTENSEN T. N. 2004. *Ecologically relevant stress resistance: from microarrays and quantitative trait loci to candidate genes - A research plan and preliminary results using Drosophila as a model organism and climatic and genetic stress as model stresses.* Biosciences. Indian Academy of Sciences. India. **29**: 503-511.

MALMENDAL A., OVERGAARD J., BUNDY J. G., SORENSEN J. G., NIELSEN N. C., LOESCHCKE V., HOLMSTRUP M. 2006. *Metabolomic profiling of heat stress: hardening and recovery of homeostasis in Drosophila.* American Journal of Physiology. Physiological Society. 291: 205-212.

RICCI M. & BUDNIK M. 1984. *Influence of temperature, density and interspecific competition on the preadult development of Chilean populations of Drosophila subobscura and Drosophila immigrans.* Brazilian Journal of Genetics. Mendeley. **7**: 255-264.

RUBIN L. 1990. *The Rubin Lab.* Berkeley.California. 185 pp.

SAITOU N. & NEI M. 1987. *The neighbor - joining method: A new method for reconstructing phylognetic trees.* Molecular Biology and Evolution. Oxford University Press. **4**: 406-425.

SISODIA S. S. & SINGH N. D. 2010. *Resistance to environmental stress in Drosophila ananassae: latitudinal variation and adaptation among populations.* Journal of Evolutionary Biology. PubMed. **23**: 1979-1988.

SORENSEN J. G., KRISTENSEN T. N., LOESCHCKE V. 2003. *The evolutionary and ecological role of heat shock proteins.* Ecology Letters. Blackwell Science Ltd. London. **6**: 1025-1037.

VAN DER LINDE K. & SEVENSTER J. G. 2006. *Local adaptation of development time and starvation resistance in eight Drosophila specie of Philippines.* Biological Journal of Linnean Society. Wiley Blackwell, London. **87**: 115-125.

Chelu Cristina, Corneanu Mihaela, Butnaru Gallia
University of Agricultural Sciences and Veterinary Medicine of Banat,
Calea Aradului 119, 300364-Timişoara,
E-mail: cristina.chelu@uex-usamvbt.org
E-mail: micorneanu@yahoo.com

Received: March 30, 2011
Accepted: August 3, 2011

A SURWEY OF KNOWN PARASITOIDES OF FAMILY CERAMBYCIDAE (INSECTA: COLEOPTERA: CHRYSOMELOIDEA)

LILA Gima

Abstract. The paper presents a survey of data on the parasite fauna on long-horned beetles taken from papers published in 1961-2009 (PANIN & SĂVULESCU, 1961; PISICĂ, 2001; PISICĂ & POPESCU, 2009). There were identified 85 species of parasites belonging to the order Hymenoptera, family Ichneumonidae, which parasitize on 67 species of host beetles.

Keywords: Ichneumonidae, Cerambycidae, parasites, beetle-host.

Rezumat. Studiul parazitoizilor întâlniţi la familia Cerambycidae (Insecta: Coleoptera: Chrysomeloidea). Lucrarea prezintă o sinteză a datelor referitoare la parazitofauna unor specii de coleoptere (Cerambycidae) preluate din lucrări publicate între 1961-2009 (PANIN & SĂVULESCU, 1961; PISICĂ, 2001; PISICĂ & POPESCU, 2009). Au fost identificate 85 specii de paraziţi aparţinând ichneumonidelor (Hymenoptera: Ichneumonidae) care parazitează 67 de specii de coleoptere-gazdă.

Cuvinte cheie: Ichneumonidae, Cerambycidae, paraziţi, coleoptere-gazdă.

INTRODUCTION

Ichneumonidae include a relatively large number of parasitic species in Romania. Adults feed on the nectar of flowers, but their larvae parasitize especially caterpillars and pupae of Lepidoptera, Coleoptera, Tenthredinidae etc. The adults may be pests of agricultural and silvicultural plants. But the larvae can be effectively used for biological control of insect pests of economically important plants (CONSTANTINEANU, 1959).

The first step in our investigation of parasites found in beetles is a synthesis of existing literary data. taken mainly from the papers published in 1961, 2001 and 2009 (PANIN & SĂVULESCU, 1961; PISICĂ, 2001; PISICĂ & POPESCU, 2009).

MATERIAL AND METODS

The taxonomy and nomenclature of the identified species is in accordance with Fauna Europaea database. The species of parasites are presented in the alphabetical order and within them, in alphabetical order on subfamilies and tribes, in tabular form, which include host of beetles. Species of beetle-hosts (Coleoptera: Cerambycidae) and the subfamilies are also arranged alphabeticaly.

RESULTS AND DISCUSSIONS

After processing the data, there were identified 85 species of parasitic Ichneumonida (Table 1) and 67 hosts species of longhomened beetles Cerambycidae (Table 2). On the left of the table there are listed the species of parasites and on the right - the species of beetles (Table 1).

Table 1. Parasites of some species of Ceranbycidae.
Tabel 1. Paraziţii unor specii de cerambicide.

No.	Taxa (subfamilies, tribes, species) Family ICHNEUMONIDAE	Species of Cerambycidae	References
Subfamily Acaenitinae			
Tribe Acaenitini			
1	*Arotes albicinctus* GRAVENHORST, 1829	*Plagionotus arcuatus* LINNÉ 1758	PISICĂ, 2001
2	*Phaenolobus saltans* (GRAVENHORST, 1829)	*Oberea (Amaurostoma) erythrocephala* (SCHRANK 1776)	
3	*P. terebrator* (SCOPOLI 1763)	*O. linearis* (LINNAEUS 1761)	
4	*P. fulvicornis* GRAVENHORST, 1829	*Phytoecia coerulescens* (SCOPOLI, 1763)	
Tribe Coleoceatrini			
5	*Coleocentrus caligatus* GRAVENHORST 1829	*Callidium* sp.	PISICĂ, 2001
		Phymatodes testaceus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Tetropium castaneum LINNÉ 1758	PANIN & SĂVULESCU, 1961
Subfamily Banchinae			
Tribe Lissonotini			
6	*Lissonota buccator* THUNBERG 1822	*Tetropium castaneum* LINNÉ 1758	PISICĂ, 2001
		T. gabrieli WEISE 1905	
Tribe Stilbopini			
7	*Glypta ephipigera* KRIECHBAUMER 1895	*Sarpeda populnea* LINNÉ 1758	PISICĂ, 2001
8	*G. rostrata* HOLMGR.	*Sarpeda populnea* LINNÉ 1758	PANIN & SĂVULESCU, 1961
9	*G. teres* GRAVENHORST 1829	*Sarpeda populnea* LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001 PISICĂ & POPESCU, 2009

Subfamily Cryptinae (Gelinae)			
Tribe Acaenitini			
10	***Acoenitus dubitator*** PANZER, 1800	*Phymatodes testaceus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Plagionotus arcuatus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Toxotus cursor LINNÉ 1758	PANIN & SĂVULESCU, 1961
Tribe Cryptini (Mesostenini)			
11	*Cryptus viduatorius* FABRICIUS 1804	*Sarpeda (Anaerea) carcharias* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		S. populnea LINNÉ 1758	
12	*Caenocryptus minator* (GRAVENHORST, 1829)	*Hylotrupes bajulus* LINNÉ 1758	
13	*C. tener* THOMPSON 1873	*Exocentrus balteatus* MEYER 1933	PISICĂ, 2001
14	*Idiolispa analis* GRAV. 1807	*Sarpeda populnea* LINNÉ 1758	
15	*Mesostenus gladiator* (SCOPOLI, 1763)	*Monochamus galloprovincialis* OLIVIER 1795	PANIN & SĂVULESCU, 1961
		M. galloprovincialis pistor GERMAR 1818	PISICĂ & POPESCU, 2009
16	*Nematopodius formosus* GRAV.	*Leiopus nebulosus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
17	*Stenarella gladiators* SCOPOLI 1763	*Monochamus galloprovincialis* OLIVIER 1795	PISICĂ, 2001
18	*Xylophrurus lancifer* GRAV.	*Hylotrupes bajulus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
19	*X. dispar* THUNBERG 1822	*Sarpeda (Anaerea) carcharias* LINNÉ 1758	PISICĂ, 2001
		S. populnea LINNÉ 1758	
Tribe Gelini			
20	*Hemiteles pedestri* FABRICIUS 1775	*Criocephalus (Arhopalus) quinquepunctatus* HARR.	PISICĂ, 2001
21	*Mastrus annulatus* BRISCHKE 1864	*Tetrops praeustus* (LINNAEUS 1758)	
Tribe Hemigasterini			
22	*Demopheles caliginosus* (GRAVENHORST, 1829)	*Clytus* sp.	PISICĂ, 2001
23	*Echthrus reluctator* L.	*Acanthocinus aedilis* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Phymatodes testaceus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Plagionotus arcuatus LINNÉ 1758	PISICĂ & POPESCU, 2009
		Rhagium inquisitor LINNÉ 1758	PISICĂ, 2001
		Sarpeda populnea LINNÉ 1758	
Tribe Phygadeuontini			
24	*Phygadeon detestator* THUMB.	*Leiopus nebulosus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
25	*Hemiteles melanarius* GRAV.	*Pogonocherus (Pityphilus) fasciculatus* DEGEER 1775	PISICĂ, 2001
Subfamily Campopleginae			
26	*Pyracmon austriacus* TSCHEK.	*Aromia moschata moschata* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Monochamus sutor LINNÉ 1758	
		Tetropium castaneum LINNÉ 1758	
		T. fuscum FABRICIUS 1787	
27	*P. lucidus* CLEM.	*Clytus arietis* LINNÉ 1758	
28	*P. xoridiformis* HOLMGR.	*Criocephalus rusticus* LINNÉ 1758	
		Leptura rubra LINNÉ 1758	
		Pogonocherus (Pityphilus) fasciculatus DEGEER 1775	
		Tetropium fuscum FABRICIUS 1787	
29	*P. xoridoideus* STROBL.	*Callidium violaceum* LINNÉ 1758	
		Mesosa (Aphelocnemia) nebulosa FABRICIUS 1781	
		Phyrrhidium sanguineum LINNÉ 1758	
		Tetropium fuscum FABRICIUS 1787	
Tribe Limnerini			
30	*Rhimphoctona fulvipes* HOLMGREN, 1858	*Rhopalopus macropus* GERMAR 1824	PISICĂ, 2001
		Sarpeda (Anaerea) carcharias LINNÉ 1758	PANIN & SĂVULESCU, 1961
Subfamily Diplozontinae			
31	*Promethes sulcator* (GRAVENHORST, 1829)	*Adimonia rustica* HW.	PISICĂ, 2001
Subfamily Ichneumoninae			
Tribe Ichneumonini			
32	*Barichneumon scriptorius* THUMB.	*Semanotus russicus russicus* FABRICIUS 1776	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
Tribe Phaeogenini			
33	*Diadromus subtilicornis* (GRAVENHORST, 1829)	*Saperda populnea* LINNÉ 1758	PISICĂ, 2001
Subfamily Lycorinae			
34	*Lycorina triangulifera* HOLMGREN, 1859	*Sarpeda populnea* LINNÉ 1758	PISICĂ, 2001
Subfamily Pimplinae (Ephialtinae)			
Tribe Perithoini			
35	*Calliclisis hectica* GRAV.	*Vadonia livida* FABRICIUS 1776	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
36	*Perithous divinator* ROSSI	*Aromia moschata moschata* LINNÉ 1758	
		Leptura quadrifasciata LINNÉ 1758	
		Monochamus galloprovincialis OLIVIER 1795	
37	*P. mediator* FABRICIUS	*M. galloprovincialis pistor* GERMAR 1818	
		Strangalia quadrifasciata LINNÉ 1758	
Tribe Ephialtini			
38	*Clistipyga sauberi* BRAUNS 1898	*Tetropium gabrieli* WEISE 1905	PISICĂ, 2001
39	*Dolichomitus aciculatus* HELLEN 1915	*T. gabrieli* WEISE 1905	
40	*D. cephalotes* HOLMGREN 1860	*Monochamus rosenmuelleri* (CEDERJELM 1798)	PISICĂ, 2001
41	*Ephialtes (Dolichomitus) dux* TSCHEK.	*Rhagium inquisitor* LINNAEUS 1758	
		Tetropium fuscum FABRICIUS 1787	PANIN & SĂVULESCU, 1961

42	*E. (Dolichomitus) gaurotii* GREGOR	*Gaurotes excellens* BRANCSIK 1874	PISICĂ, 2001
43	*E. manifestator* L.	*Cerambix cerdo* LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Clytus tropicus PANZER 1795	PANIN & SĂVULESCU, 1961
		C. lama MULSANT 1847	
		Hylotrupes bajulus LINNÉ 1758	
		Oberea oculata LINNÉ 1758	
		Phymatodes testaceus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Plagionotus arcuatus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Pogonocherus hispidus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		P. hispidulus PILLER & MITTERPACHER 1783	PISICĂ, 2001
		P. (Pityphilus) fasciculatus DEGEER 1775	PANIN & SĂVULESCU, 1961
		Sarpeda populnea LINNÉ 1758	PISICĂ, 2001
		Spondylis buprestoides LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Xylotrecus rusticus LINNÉ 1758	
44	*E. (Dolichomitus) mesocentrus* GRAV.	*Acanthocinus aedilis* LINNÉ 1758	
		Cerambix scopoli FUESSLY 1775	
		Gaurotes excellens BRANCSIK 1874	
		Phymatodes testaceus LINNÉ 1758	
		Plagionotus detritus LINNÉ 1758	
		Purpuricenus kaehleri LINNÉ 1758	
45	*E. (Dolichomitus) messor* GRAV.	*Aromia moschata moschata* LINNÉ 1758	
		Lamia textor LINNÉ 1758	
		Oberea oculata LINNÉ 1758	
		Sarpeda populnea LINNÉ 1758	
46	*E. (Dolichomitus) populneus* RTZB.	*S. populnea* LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		S. (Anaerea) carcharias LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Plagionotus arcuatus LINNÉ 1758	PISICĂ, 2001
		Rhagium inquisitor LINNÉ 1758	
47	*E. (Dolichomitus) tuberculatus* FOURCR.	*Acanthocinus aedilis* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Aromia moschata moschata LINNÉ 1758	
		Cerambix cerdo LINNÉ 1758	
		C. scopoli FUESSLY 1775	
		Gaurotes excellens BRANCSIK 1874	
		Monochamus galloprovincialis OLIVIER 1795	
		M. galloprovincialis pistor GERMAR 1818	
		Oplosia fennica PAYKULL 1800	
		Phymatodes testaceus LINNÉ 1758	
		Rhagium mordax DEGEER 1775	
48	*E. (Dolichomitus) terebrans* RATZEBURG	*Pogonocherus (Pityphilus) fasciculatus* DEGEER 1775	
		P. hispidus LINNÉ 1758	
		Tetropium fuscum FABRICIUS 1787	
49	*E. (Townesia) tenuiventris* HOLMGR.	*Phymatodes testaceus* LINNÉ 1758	
		Sarpeda populnea LINNÉ 1758	PISICĂ, 2001
50	*E. (Dolichomitus) sagax* HARTING	*Pogonocherus (Pityphilus) fasciculatus* DEGEER 1775	PANIN & SĂVULESCU, 1961
51	*E. (Dolichomitus) sericeus* HARTIG 1847	*Tetropium cinnamopterum* KIRBY 1837	PISICĂ, 2001
		Tetropium sp.	
52	*E. subglabratus* PERK.	*Molorchus (Caenoptera) minor* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Phymatodes testaceus LINNÉ 1758	
53	*Paraperithos gnahtaulax* THOMPSON 1877	*Achantocinus carinulatus* GEBLER 1833	PISICĂ, 2001
54	*Scambus triangularis* VERHOEFF 1890	*Oberea linearis* (LINNAEUS 1761)	
55	*Townesia tenuivenrtis* HOLMGREN 1860	*Sarpeda populnea* LINNÉ 1758	
Tribe Theroniini			
56	*Atractogaster semisculptus* KRIECHBAUMER 1872	*Acanthocinus aedilis* LINNÉ 1758	PISICĂ, 2001
57	*Pseudorhyssa maculicoxis* KRIECHBAUMER 1889	*Monochamus* sp.	PISICĂ, 2001
Subfamily Orthocentrinae			
58	*Orthocentrus fulvipes* GRAV.	*Leiopus nebulosus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Sarpeda scalaris LINNÉ 1758	
Subfamily Phaeoginae			
59	*Proscus suspicax* WESM.	*Sarpeda populnea* LINNÉ 1758	PANIN & SĂVULESCU, 1961
Subfamily Poemeniinae			
Tribe Poemeniini			
60	*Neoxorides collaris* GRAV.	*Acanthocinus aedilis* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		A. carinulatus GEBLER 1833	PISICĂ, 2001
		Plagionotus arcuatus LINNÉ 1758	
		Rhagium inquisitor LINNÉ 1758	
		Tetropium castaneum LINNÉ 1758	

		T. fuscum FABRICIUS 1787	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		T. gabrieli WEISE 1905	PISICĂ, 2001
61	*N. nitens* var. *albicollis* CLÉM.	*Plagionotus detritus* LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
62	*N. nitens* GRAV.	*Asemum striatum* LINNÉ 1758	PISICĂ, 2001
		Clytus arietis LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Clytus sp.	PISICĂ, 2001
		Phymatodes testaceus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Phyrrhidium sanguineum LINNÉ 1758	
		Plagionotus arcuatus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		P. detritus LINNÉ 1758	
		Sarpeda (Anaerea) carcharias LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Tetropium castaneum LINNÉ 1758	
63	*Deuteroxorides albitarsus* GRAV.	*Callidium aeneum* DE GEER 1775	PISICĂ, 2001
		Leiopus nebulosus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		L. nebulosus LINNÉ 1758	PISICĂ, 2001
		Prionus coriarus LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
64	*Poemia notata* HOLMGREN, 1859	*Nothorhina punctata* (DALMAN 1817)	PISICĂ, 2001
65	*Podoschistus scutellaris* DESVIGNES 1856	*Clytus arietis* LINNÉ 1758	
		Leiopus nebulosus LINNÉ 1758	
Subfamily Rhyssinae			
Tribe Rhyssini			
66	*Rhyssa amoena* GRAV.	*Criocephalus rusticus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Cerambix cerdo LINNÉ 1758	PISICĂ, 2001
		Monochamus sutor LINNÉ 1758	
67	*R. persuasoria* L.	*Tetropium fuscum* FABRICIUS 1787	PANIN & SĂVULESCU, 1961
		T. gabrieli WEISE 1905	PISICĂ, 2001
		Cerambix cerdo LINNÉ 1758	
		C. scopoli FUESSLY 1775	
		Monochamus sartor FABRICIUS 1787	
		Spondylis buprestoides LINNÉ 1758	
Subfamily Xoridinae			
68	*Sichelia filiformis* GRAV.	*Acanthocinus aedilis* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Callidium aeneum DEGEER 1775	
		Clytus tropicus PANZER 1795	
		Phymatodes testaceus LINNÉ 1758	
		Phyrrhidium sanguineum LINNÉ 1758	
		Plagionotus arcuatus LINNÉ 1758	
		P. detritus LINNÉ 1758	
		Rhagium inquisitor LINNÉ 1758	
		Xylotrecus rusticus LINNÉ 1758	
69	*Xylophrura lancifer* GRAV.	*Sarpeda populnea* LINNÉ 1758	
70	*Xorides ater* GRAVENHORST 1829	*Criocephalus rusticus* LINNÉ 1758	PISICĂ, 2001
		Tetropium castaneum LINNÉ 1758	
		T. fuscum FABRICIUS 1787	
		T. gabrieli WEISE 1905	
71	*X. alpestris* HABERMEHL 1903	*Necydalis major* LINNAEUS 1758	
72	*X. brachyalis* KRIECHBAUMER 1889	*Tetropium castaneum* LINNÉ 1758	
		T. fuscum FABRICIUS 1787	
		T. gabrieli WEISE 1905	
73	*X. fuliginator* THUMB.	*Acanthoderes clavipes* SCHRANK 1781	PANIN & SĂVULESCU, 1961
		Criocephalus rusticus LINNÉ 1758	
74	*X. gracilicornis* GRAVENHORST 1829	*Molorchus minor* LINNÉ 1758	PISICĂ, 2001
75	*X. (Xorides) irrigator* FABRICIUS 1793	*Acanthocinus aedilis* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Acanthocinus carinulatus GEBLER 1833	PISICĂ, 2001
		Mesosa (Aphelocnemia) nebulosa FABRICIUS 1781	PANIN & SĂVULESCU, 1961
		Tetropium gabrieli WEISE 1905	PISICĂ, 2001
		Plagionotus arcuatus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Rhagium inquisitor LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
76	*X. niger* PFEFFER var. *bicolor* GRAV.	*Tetropium castaneum* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Molorchus minor LINNÉ 1758	PISICĂ, 2001
77	*X. (Gonophonus) propinquus* TSCHEK .	*M. minor* LINNÉ 1758	
		Niphona picticornis MULSANT 1839	
		Semanotus russicus russicus FABRICIUS 1776	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
		Trichoferus griseus FABRICIUS 1792	PISICĂ, 2001

78	*X. (Xorides) praecatorius* F.	*Aromia moschata moschata* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Callidium aeneum DEGEER 1775	PISICĂ, 2001
		Gaurotes excellens BRANCSIK 1874	PANIN & SĂVULESCU, 1961
		Tetropium castaneum LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Phymatodes testaceus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Phyrrhidium sanguineum LINNÉ 1758	PISICĂ, 2001
		Plagionotus arcuatus LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Sarpeda scalaris LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Tetropium fuscum FABRICIUS 1787	PISICĂ, 2001
		Callidium violaceum LINNÉ 1758	PISICĂ, 2001
		Leiopus nebulosus LINNÉ 1758	
		Tetropium castaneum LINNÉ 1758	
79	*X. (Moerophora) rufipes* GRAV.	*Rhagium inquisitor* LINNÉ 1758	PANIN & SĂVULESCU, 1961 PISICĂ, 2001
80	*X. securicornis* HOLMGR.	*Leiopus nebulosus* LINNÉ 1758	PANIN & SĂVULESCU, 1961
		Phymatodes alnis LINNÉ 1758	PISICĂ, 2001
		P. (Poecilium) fasciatus VILLERS, 1789	
81	*Ischnoceros caligatus* GRAVENHORST 1829	*Aromia moschata* LINNÉ 1758	PISICĂ, 2001
		Criocephalus rusticus LINNÉ 1758	
		Leiopus nebulosus LINNÉ 1758	
		Rhagium bifasciatum FABRICIUS 1775	
		R. inquisitor LINNÉ 1758	
		R. mordax DEGEER 1775	
		Sarpeda carcharias LINNÉ 1758	
82	*I. caligatus* GRAVENHORST 1829	*Aromia moschata* LINNÉ 1758	
		Rhagium mordax DEGEER 1775	
		R. bifasciatum FABRICIUS 1775	
		Sarpeda carcharias LINNÉ 1758	
83	*Odontocolon dentipes* GMELIN, 1790	*Criocephalus rusticus* LINNÉ 1758	
		Spondylis buprestoides LINNÉ 1758	
84	*O. quercinum* THOMSON 1877	*Monochamus galloprovincialis* OLIVIER 1795	
85	*O. spinipes* GRAVENHORST 1829	*Pogonocherus hispidulus* PILLER & MITTERPACHER 1783	
		Rhagium sp.	

The 85 species of parasitich Ichneumonids belong to 13 subfamilies: Acaenitinae (5 species), Banchinae (4 species), Cryptinae (16 species), Campopleginae (5 species), Diplozontinae (1 species), Ichneumoninae (2 species), Lycorinae (1 species), Pimplinae (23 species), Orthocentrinae (1 species), Phaeoginae (1 species), Poemeniinae (6 species), Rhyssinae (2 species), and Xoridinae (18 species). Some of the subfamilies are subdivided into tribes (Table 2).

Table 2. Numerical and percentage distribution of the parasite species on subfamilies and tribes.
Tabel 2. Distribuţia numerică şi procentuală a speciilor de paraziţi pe subfamilii şi triburi.

No.	Subfamilies	Tribes	No. of species		%
1	Subfamily Acaenitinae	Tribe Acaenitini	4	5	7%
		Tribe Coleoceatrini	1		
2	Subfamily Banchinae	Tribe Lissonotini	1	4	5%
		Tribe Stilbopini	3		
3	Subfamily Cryptinae (Gelinae)	Tribe Acaenitini	1	16	21%
		Tribe Cryptini (Mesostenini)	9		
		Tribe Gelini	2		
		Tribe Hemigasterini	2		
		Tribe Phygadeuontini	2		
4	Subfamily Campopleginae		4	5	7%
		Tribe Limnerini	1		
5	Subfamily Diplozontinae		1	1	1%
6	Subfamily Ichneumoninae	Tribe Ichneumonini	1	2	3%
		Tribe Phaeogenini	1		
7	Subfamily Lycorinae		1	1	1%
8	Subfamily Pimplinae	Tribe Ephialtini	18	23	31%
		Tribe Perithoini	3		
		Tribe Theroniini	2		
9	Subfamily Orthocentrinae		1	1	1%
10	Subfamily Phaeoginae		1	1	1%
11	Subfamily Poemeniinae	Tribe Poemeniini	6	6	8%
12	Subfamily Rhyssinae	Tribe Rhyssini	2	2	3%
13	Subfamily Xoridinae		18	18	11%
Total			**85**	**85**	**100**

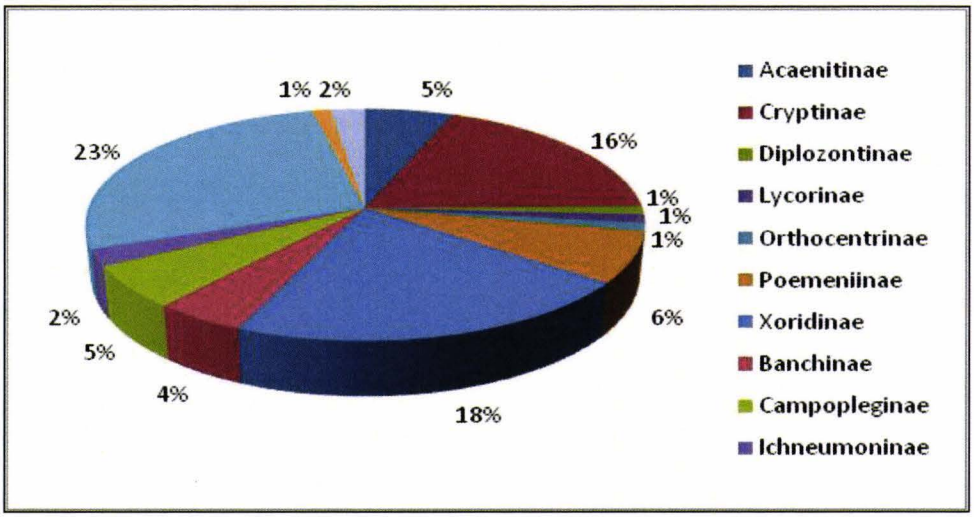


Figure 1. Comparative percentages of species of the family Ichneumonidae.
Figura 1. Procentajele comparative ale speciilor de paraziți (Ichneumonidae).

Most parasites found on long-horned beetles belong to Pimplinae subfamily (23 species), while the lowest number (each one species) belongs to the subfamilies Diplozontinae, Lycorinae, Orthocentrinae and Phaeoginae (Fig. 1).

Most host beetle belong the subfamily Lamiinae (26 species), and other hosts belong to the following subfamilies: Cerambycinae (21 species), Lepturinae (8 species), Necydalinae (1 species), Prioninae (1 species) and Spondylidinae (11 species) (Fig. 2).

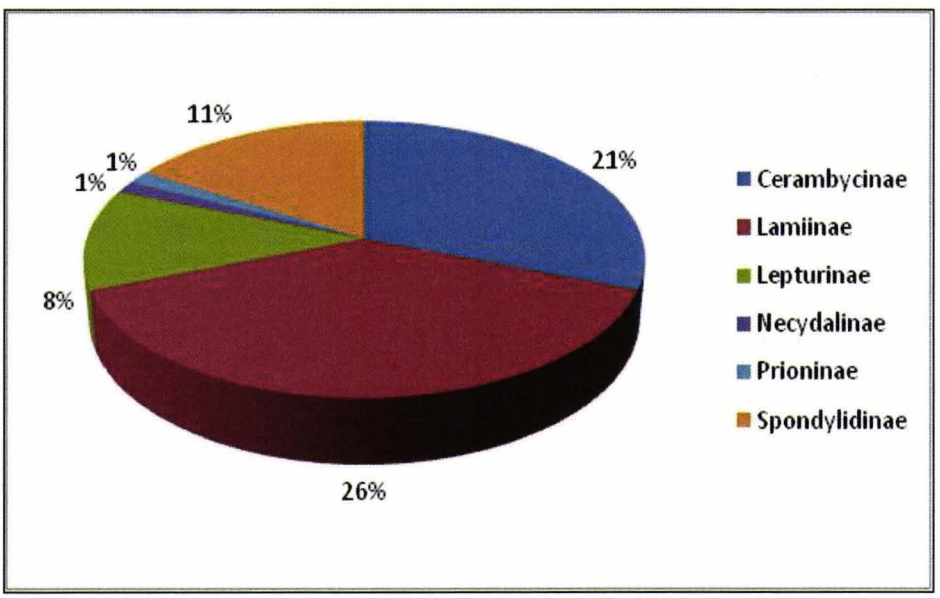


Figure 2. Distribution of subfamilies within the family of Cerambycidae.
Figura 2. Distribuția subfamiliilor în cadrul familiei Cerambycidae.

We analized the data to be useful material and in terms of diversity of hosts. We found 67 species of beetles belonging to the family Cerambycidae. Each of them are hosts of several species of parasites (Table 3).

Table 3. Cerambycid host species for Ichneumonidae.
Tabel 3. Specii de cerambycide-gazdă pentru Ichneumonidae.

No.	Species of beetles	Subfamilies of beetles
1	*Aromia moschata moschata* LINNÉ 1758	Subfamily Cerambycinae
2	*Callidium aeneum* DEGEER 1775	
3	*C. violaceum* LINNÉ 1758	
4	*Cerambix cerdo* LINNÉ 1758	
5	*C. scopoli* FUESSLY 1775	
6	*Clytus arietis* LINNÉ 1758	
7	*C. lama* MULSANT 1847	
8	*C. tropicus* PANZER 1795	

9	*Hylotrupes bajulus* LINNÉ 1758	Subfamily Cerambycinae
10	*Molorchus (Caenoptera) minor* LINNÉ 1758	
11	*Phymatodes alnis* LINNÉ 1758	
12	*P. (Poecilium) fasciatus* VILLERS, 1789	
13	*Phyrrhidium sanguineum* LINNÉ 1758	
14	*P. testaceus* LINNÉ 1758	
15	*Plagionotus arcuatus* LINNÉ 1758	
16	*P. detritus* LINNÉ 1758	
17	*Purpuricenus kaehleri* LINNÉ 1758	
18	*Rhopalopus macropus* GERMAR 1824	
19	*Semanotus russicus russicus* FABRICIUS 1776	
20	*Trichoferus griseus* FABRICIUS 1792	
21	*Xylotrecus (Rusticoclytus) rusticus* LINNÉ 1758	
22	*Acanthoderes (Aegomorphu) clavipes* SCHRANK 1781	Subfamily Lamiinae
23	*Acanthocinus aedilis* LINNÉ 1758	
24	*A. carinulatus* GEBLER 1833	
25	*Lamia textor* LINNÉ 1758	
26	*Mesosa (Aphelocnemia) nebulosa* FABRICIUS 1781	
27	*Monochamus galloprovincialis* OLIVIER 1795	
28	*M. galloprovincialis pistor* GERMAR 1818	
29	*M. rosenmulleri* (CEDERJELM 1798)	
30	*M. sartor* FABRICIUS 1787	
31	*M. sutor* LINNÉ 1758	
32	*Niphona picticornis* MULSANT 1839	
33	*Oberea (Amaurostoma) erythrocephala* (SCHRANK 1776)	
34	*O. oculata* LINNÉ 1758	
35	*O. linearis* (LINNAEUS 1761)	
36	*Phytoecia coerulescens* (SCOPOLI, 1763)	
37	*Pogonocherus (Pityphilus) fasciculatus* DEGEER 1775	
38	*P. hispidulus* PILLER & MITTERPACHER 1783	
39	*P. hispidus* LINNÉ 1758	
40	*Acanthocinus aedilis* LINNÉ 1758	
41	*A. carinulatus* GEBLER 1833	
42	*Leiopus nebulosus* LINNÉ 1758	
43	*Sarpeda (Anaerea) carcharias* LINNÉ 1758	
44	*S. populnea* LINNÉ 1758	
45	*S. scalaris* LINNÉ 1758	
46	*Tetrops praeustus* (LINNAEUS 1758)	
47	*Gaurotes excellens* BRANCSIK 1874	Subfamily Lepturinae
48	*Leptura rubra* LINNÉ 1758	
49	*L. quadrifasciata* LINNÉ 1758	
50	*Rhagium inquisitor* LINNÉ 1758	
51	*R. bifasciatum* FABRICIUS 1775	
52	*R. mordax* DEGEER 1775	
53	*Strangalia quadrifasciata* LINNÉ 1758	
54	*Vadonia livida* FABRICIUS 1776	
55	*Necydalis major* LINNAEUS 1758	Subfamily Necydalinae
56	*Prionus coriarus* LINNÉ 1758	Subfamily Prioninae
57	*Arhopalus rusticus* LINNÉ 1758	Subfamily Spondylidinae
58	*Asemum striatum* LINNÉ 1758	
59	*Criocephalus (Arhopalus) quinquepunctatus* HARR.	
60	*C. rusticus* LINNÉ 1758	
61	*C. quinquepunctatus* HARR.	
62	*Nothorhina punctata* (DALMAN 1817)	
63	*Spondylis buprestoides* LINNÉ 1758	
64	*Tetropium castaneum* LINNÉ 1758	
65	*T. cinnamopterum* KIRBY 1837	
66	*T. fuscum* FABRICIUS 1787	
67	*T. gabrieli* WEISE 1905	

Most host beetle found in the subfamily Lamiinae (25 species), and other parasites belong to the following subfamilies: subfamily Cerambycinae (21 species), subfamily Lepturinae (8 species), subfamily Necydalinae (1 species), subfamily Prioninae (1 species) and subfamily Spondylidinae (11 species) (Fig. 2).

AKNOWLEDGEMENTS

Thanks to Mrs. PhD. Chimisliu Cornelia for material made available and, especially, Mr. Prof. PhD. Varvara Mircea for material made available and for precious guidances.

REFERENCES

CONSTANTINEANU M. I. 1959. *Familia Ichneumonidae. Subfamilia Ichneumoninae.* In: Fauna R.P.R. Insecta. Edit. Academiei Române, Bucureşti. **9**(4): 1-26.

PANIN S. & SĂVULESCU N. 1961. *Coleoptera. Familia Cerambycidae (Croitori).* In: Fauna R.P.R. Insecta. Edit. Academiei Române, Bucureşti. **10**(6): 79-504.

PISICĂ C. 2001. *Ichneumonidele (Hymenoptera, Insecta) din Romania şi gazdele lor.* Catalog. Edit. Universităţii „Alexandru Ioan Cuza", Iaşi: 7-334.

PISICĂ C. & POPESCU I. 2009. *Le Catalogue des Ichneumonides (Hymenoptera: Ichneumonidae) de Roumanie.* Editura PIM, Iaşi. 9-289.

***. http//www.faunaeur.org (accesed: March 12, 2011).

Lila Gima
The Oltenia Museum Craiova, Natural Sciences Department
Popa Şapcă Street, No. 8, Craiova, Romania
E-mail: lilagima@yahoo.com

Received: March 27, 2011
Accepted: August 28, 2011

EXPERIMENTAL WORKS REGARDING THE EARLY STAGES GROWTH AT *Ancistrus brevipinnis* (REGAN, 1904) AND *Corydoras aeneus* (GILL, 1858), UNDER SOME STRESSING FACTORS INFLUENCE

CHIOREAN Adriana, STĂNCIOIU Soare, DUMITRESCU Elena, ALEXANDROV Laura

Abstract. This paper presents the results obtained by the authors in experimental trials, concerning the assessment of the main environmental factors (temperature, pH, light), of two exotic species, *Corydoras aeneus* (GILL, 1858) and *Ancistrus brevipinnis* (REGAN, 1904) (BREZEANU, 1972; SANDERS, 1993; SEGNERH & VERRETH, 1958) studied and reared in the Constanta Aquarium laboratories. The experiments proved that the maintaining of these parameters at greater or lower values than normal has as effect the slowdown of fish growth. Consequently water temperatures maintaining at 32°C, comparing with the normal ones (23 and 28°C), the pH reducing at 5-5.5 (normal values being 6 to 8) had obvious influences on the decrease of the studied species growth. Continuous lighting proved to have a lower influence on fish; even these species prefer dark conditions, they felt this danger and started to group in the darker corners of the basins.

Keywords: Aquarium, environmental factors, exotic fishes, captivity, stress.

Rezumat. Experimente de dezvoltare a stadiilor timpurii la speciile *Ancistrus brevipinnis* (REGAN, 1904) şi *Corydoras aeneus* (GILL, 1858) supuse unor factori stresanţi. În această lucrare, autorii evidenţiază principalii factori de mediu (temperatura, ph-ul, lumina) implicaţi în creşterea a două specii exotice luate în studiu, *Corydoras aeneus* (GILL, 1858) şi *Ancistrus brevipinnis* (REGAN, 1904), factori, care menţinuţi la valori mai mari sau mai mici decât cele normale, încetinesc creşterea peştilor. Astfel, temperaturi ale apei de 32°Celsius (normal fiind 23-28°C), ph diminuat la 5-5.5 (faţă de valorile normale de 6-8), au avut influenţe evidente în reducerea creşterii speciei *Corydoras aeneus* (GILL, 1858) şi *Ancistrus brevipinnis* (REGAN, 1904). O influenţă ceva mai redusă s-a dovedit a o avea iluminatul non-stop, peştii, deşi iubitori de întuneric, au sesizat acest pericol, cantonându-se pe la colţurile bazinelor mai puţin iluminate. Scăderea concentraţiei de oxigen sub valorile normale, determină apariţia de radicali liberi ai acestuia, nocivi organismului.

Cuvinte cheie: Acvariu, factori de mediu, peşti exotici, captivitate, stres.

INTRODUCTION

Stress conditions are very numerous: temperature oscillations, improper chemistry, fish tiredness due to transport, recurrent manipulations, recurrent treatments, population's high density in the basin, life carried inside a small volume of water, populating the same basins with fish of different sizes, lengths, nutritional lacks, traumas, improper lighting, etc. These factors may act solitarily, but they usually act together. There are situations when their slow and prolonged involvement leads to the accommodation at imposed conditions, but stressors usually bring negative influences (ROŞCA, 1977).

MATERIAL AND METHODS

The species *Ancistrus brevipinnis* (REGAN, 1904) is part of Loricariidae family, which is the richest species from all siluriformes (about 23% out of all species) and the fifth in the hierarchy of the families with the most numerous species from all teleosteans (about 3% from all species), holding 818 species, more than 104 species from the genus Ancistrus (NELSON, 2006) (Table 1).

The exotic species *Ancistrus* sp. (Fig. 1) entered Romania in the spring of 1984 and was first proliferated in 1985. This species was important in GDR [German Democratic Republic], together with other exotic fish species, as *Poecilia sphenops* (VALENCIENNES, 1846) and *Symphysodon aequifasciatus* (PELLEGRIN, 1904).

Table 1. Systematic appraisal of the species *Ancistrus brevipinnis* (REGAN, 1904).
Tabel 1. Incadrarea sistematică a speciei *Ancistrus brevipinnis* (REGAN, 1904).

Class: Actinopterygii →	**Order**: Siluriformes →	**Familia**: Loricariidae →
Subfamily: Ancistrinae →	**Genus**: *Ancistrus* →	**Species**: *A. brevipinnis* (REGAN, 1904)
Synonyms: *Xenocara brevipinnis* REGAN, 1904		
Species from the same genus: *Ancistrus* sp. (REGAN, 1904)		

The exotic species *Corydoras aeneus* (GILL, 1858) is part of Callichthydae family (Table 2), which includes 198 species and 186 from *Corydoras* genus; *Corydoras aeneus* species (GILL, 1858), known as "catfish", is one of the most popular species bred in aquariums (Fig. 2).

a. b. c.

Figure 1. Specimens of *Ancistrus brevipinnis* (REGAN, 1904): a. male; b. geographical distribution of species; c. female (original).
Figura 1. Exemplare de *Ancistrus brevipinnis* (REGAN, 1904): a. mascul; b. distribuţia geografică a speciei; c. femelă (original).

Table 2. Systematic appraisal of the species *Corydoras aeneus* (GILL, 1858).
Tabel 2. Incadrarea sistematică a speciei *Corydoras aeneus* (GILL, 1858).

Class: Actinopterygii	**Order**: Siluriformes	**Family**: Callichthyidae
Subfamily: Corydoradinae	**Genus**: *Corydoras*	**Species**: *C. aeneues* (GILL, 1858)
Synonyms: *Callichthys aeneus* (GILL, 1858), *Corydoras aeheus* (GILL, 1858), *C. aenaeus* (GILL, 1858), *C. macrosteus* (REGAN, 1912), *C. microps* (EIGENMANN & KENNEDY, 1903), *C. schultzei* (HOLLY, 1940), *C. schulzei* (HOLLY, 1940).		
Species of the same genus: *Corydoras* sp. - 186		

a. b. c.

Figure 2. Specimens of *Corydoras aeneus* (GILL, 1858): a. classical shape;
b. geographical distribution of the species; c. albino variety (original photo).
Figura 2. Exemplare de *Corydoras aeneus* (GILL, 1858): a. forma clasică;
b. distribuţia geografică a speciei; c. forma albinoasă (original).

In order to study exotic fish growth under stress conditions produced by the variation of three important environment indicators like abnormal temperatures, pH changes and lighting, there were used:

- 80 samples of *Corydoras aeneus* (GILL, 1858), each sample having an average weight of approximately 1.5 g 6 months old;
- 80 samples of *Ancistrus brevipinnis* (REGAN, 1904), with about 0.3 g/sample average weight, 4 months old.

The *Corydoras aeneus* (GILL, 1858) and *Ancistrus brevipinnis* (REGAN, 1904) samples were split in groups of 20, while other 20 samples made up the control group variant (C).

For a period of 30 days, the experimental groups were reared under environmental parameter changes, nominated stressing factors, in the following way:

- one group was exposed to high temperature (32°C);
- one group was exposed to an acid pH (Ph = 4.5-5.5);
- one group was exposed to continuous lighting (day and night) for the whole period (30 days).

So, each group was exposed under one single parameter variation. The other conditions of life regarding technical and technological aspects (precincts size, water volume, development stages, feeding regime, etc.) were identical.

In order to be able to observe separately the evolution of each sample from the two studied species, *Corydoras aeneus* (GILL, 1858) and *Ancistrus brevipinnis* (REGAN, 1904), one sample was introduced in 5 litre aquarium volume, in bubbling water. For testing the behaviour of organisms under pH variations, it was used a 120 litre aquarium, split by vertical glass walls, so that these 20 samples to be launched individually in each side of the experimental vessel. The aquarium was equipped with an external filter, which held inside the product that induced the pH variation. By these

several environmental factors changing, it was planned to be observed the way of accommodation/adapting conditions of each one to the new life conditions, and also their influence on fish growth and then on their reproduction.

There were made morphological measurements of the experimental samples and it was counted the growth ratio of each species. The aim of these was to evaluate the rearing of early stages of the studied species in different conditions and the impact of different stressors on their growth (BOGATU & MUNTEANU, 2003; COCIU, 1999; OPREA et al., 2000; SEGNER & VERRETH, 1958; SANDERS, 1993).

RESULTS AND DISCUSSIONS

Temperature, pH and light are ones of the most important abiotic factors. Their sudden variation, during a certain amount of time, subjects the organism to a shock, so that survival, or of the aquatic animals have a lot to suffer.

For the *Corydoras aeneus* (GILL, 1858) the following individual weights were recorded at the beginning of the experiment (Table 3).

Table 3. *Corydoras aeneus* (GILL, 1858) main body measurements in experimental conditions.
Tabel 3. *Corydoras aeneus* (GILL, 1858) utilizaţi în experimentările de stres.

No.	Parameters	Minimal weight (g)	Maximal weight (g)	Average weight (g)
1.	Control group	1.250	2.250	1.522
2	pH	1.020	2.560	1.555
3.	Temperature	1.130	2.400	1.635
4.	Light	1.080	2.440	1.639

For the control groups and for the group reared in acid pH environment, the average weights was about 1.5 g/sample at the start of the experimental period, and for those reared at a higher temperature of 32°C and also at continuous lighting regime, the average weights were about 1.630 g/sample.

After 30 days of growing in stressful conditions, caused by those three variables, there have been registered differences of fish growth between experimental groups (Fig. 3).

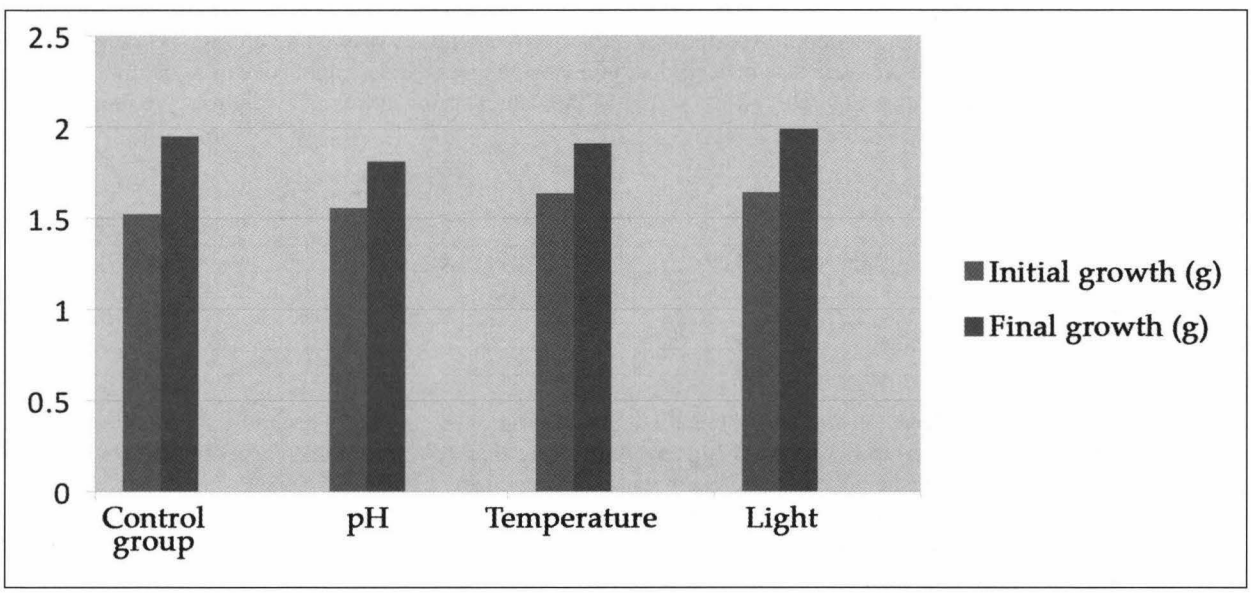


Figure 3. Growth of the species *Corydoras aeneus* (GILL, 1858) living in stress conditions (medium values).
Figura 3. Creşterea speciei *Corydoras aeneus* (GILL, 1858) în condiţii de stres (valori medii).

The samples from the control group and those stressed by temperature and the continuous lighting recorded the highest individual weights (as average values), slightly superior with 1.99 g/sample, while the samples from the group living in substantially reduced pH (comparing to the normal values for this species), grew less, the individual average value amounting 1.810 g/sample.

Analysing the rate of growth in all experimental variants, it clearly results that the control group had the most significant growth, its average value reaching 0.427 g/sample (Fig. 4).

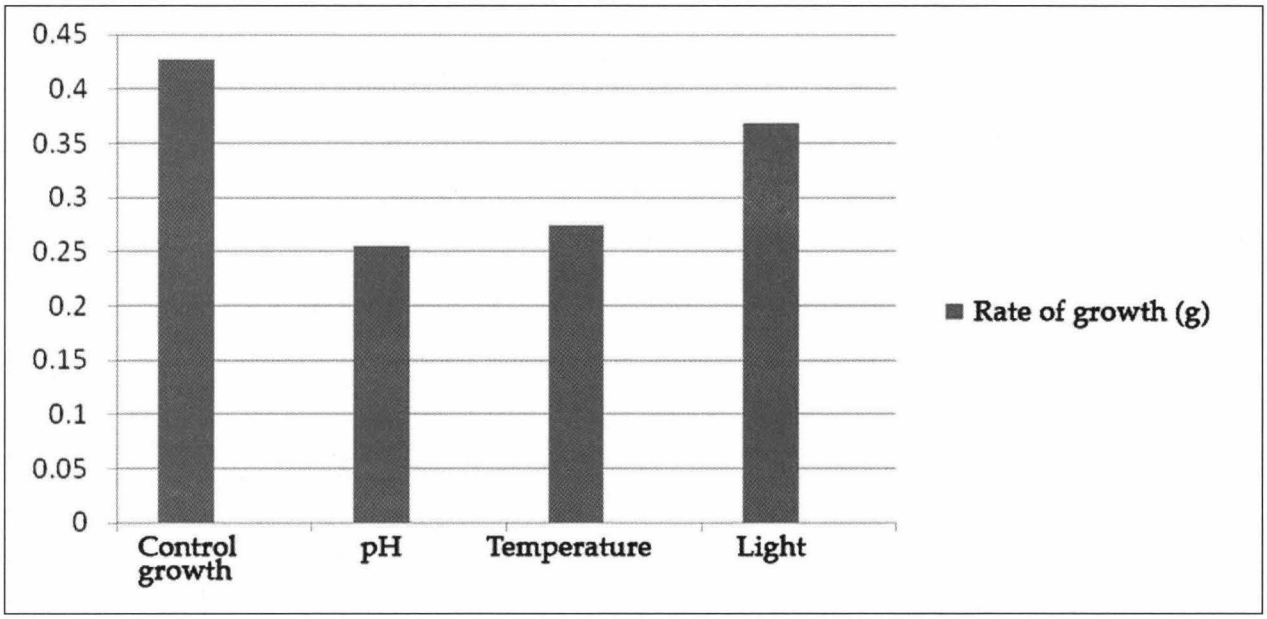


Figure 4. The growth rate recorded to *Corydoras aeneus* (GILL, 1858) reared under stressing factors.
Figura 4. Sporul de creştere înregistrat la specia *Corydoras aeneus* (GILL, 1858) supusă unor factori stresanți.

The most important influence on the studied species growth was produced by water acidity, followed by temperature and lighting changes. The average values of the rates of growth were 0.255 g/sample for the group living in acid pH environment, 0.275 g/sample, for those reared to higher temperature (32ºC) and 0.369 g/sample for the fish developed in continuous lighting conditions. Although, being a benthic species, fond of dark environment, its samples managed to refuge near the aquarium walls, in less lightened areas, so that continuous lighting variant less affected the organisms. In the other case of high temperature and low pH, the fish were more stressed and their growth was seriously slowed down. For these groups, there were also observed a diminished appetite and a slight state of agitation.

Referring to the *Ancistrus brevipinnis* (REGAN, 1904), the values of the individual weights were the following, at the beginning of the experiment (Table 4).

Table 4. *Ancistrus brevipinnis* (REGAN, 1904) main body parameter used in *stress* experiments.
Tabel 4. *Ancistrus brevipinnis* (REGAN, 1904) utilizat în experimentările de stress.

No.	Parametres	Minimal weight (g)	Maximal weight (g)	Average weight (g)
1.	Control group	0.210	0.570	0.305
2.	pH	0.230	0.870	0.302
3.	Temperature	0.120	0.640	0.225
4.	Light	0.170	0.810	0.319

The *Ancistrus brevipinnis* (REGAN, 1904) small stages had an average weight around 0.3g/sample, excepting the fish group which was planned to be reared at higher temperature than the maximum registered in their traditional environment, where the organisms weighed 0.22 g/exemplar, average value.

After the growing period, in all three experimental variants under the stress conditions of life, caused by three parameter changes, as it was mentioned, pH reduction to 4-4.5, temperature growth up to 32ºC and continuous lighting instead of normal ratio (16 hours light and 8 hours night), the following results were recorded (Fig. 5).

For the control group, as expected, the highest weight growth was recorded, the average value being 0.520 g/ sample.

For the samples living in an environment characterized by a low pH and high temperature, the fish growth was substantially slow, as well as the average weight values registered, 0.410 g/sample and 0.360 g/sample.

The results of these experiments were more clearly highlighted when the rates of growth were analysed for each experiment category, separately (Fig. 6).

According with the previous graph, it is obviously shown the net dominance of the growth rate of *Ancistrus brevipinnis* (REGAN, 1904), at its control group level for which all normal life conditions of the species were ensured. In the other three variants, more reduced growing rates were registered, the growth being slower because of the stress caused by the acid pH variant, the much higher temperature than the normal value and the continuous lighting (the species having traditionally nocturnal activity). In these conditions, the average rates of growth were: 0.215 g/sample for the control group, 0.108 g/sample for the group with acid pH, 0.135 g/sample for the group with high temperature and 0.1705 g/sample for the fish group which was stressed by continuous lighting.

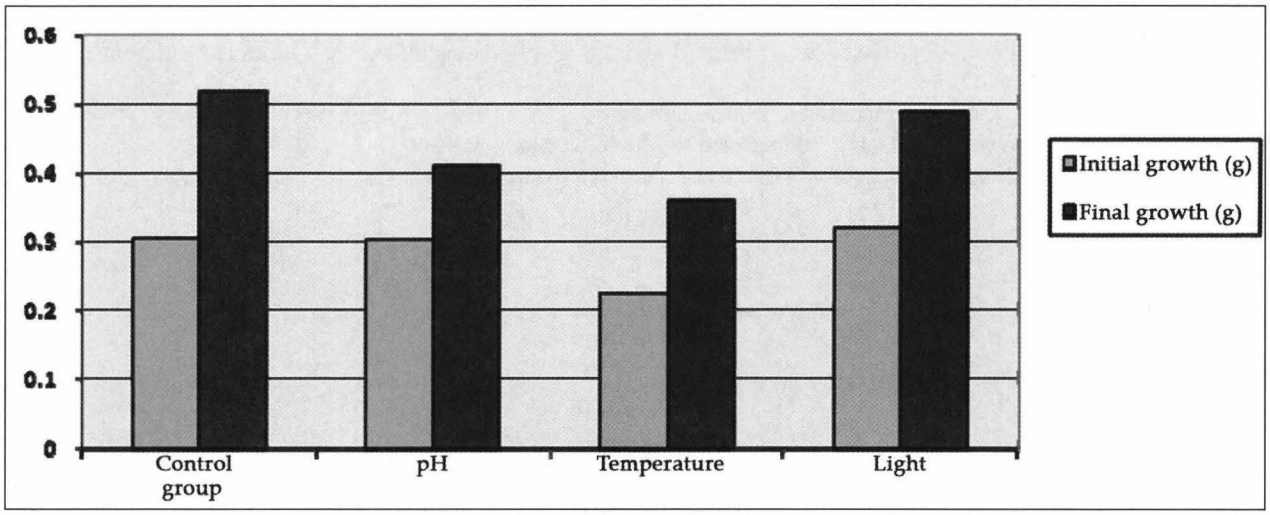


Figure 5. The growth registered at experimental species *Ancistrus brevipinnis* (REGAN, 1904), under stress conditions (average values).
Figura 5. Creşterea specieie *Ancistrus brevipinnis* (REGAN, 1904) în condiţii de stres (valori medii).

CONCLUSIONS

To conclude, it is mentioned that the main environment factors involved in the experimental studies of the *Corydoras aeneus* (GILL, 1858) and *Ancistrus brevipinnis* (REGAN, 1904) for early stages growing are temperature, pH and light regime. If they are changed and maintained at higher or lower values than the normal ones, they act as stressors for the small reared fish, causing body diminished growth, which is clearly rendered in tables and graphs. The main values of environment changing factors were 32°C water temperatures, 5-5.5 diminished pH compared with the normal 6-8, all influencing the reduction of evaluated species growth. It was emphasized that continuous lightning exerted a lower influence on fish samples; as the species prefer dark conditions, fish samples felt the danger and all grouped in the darker corners of the basins.

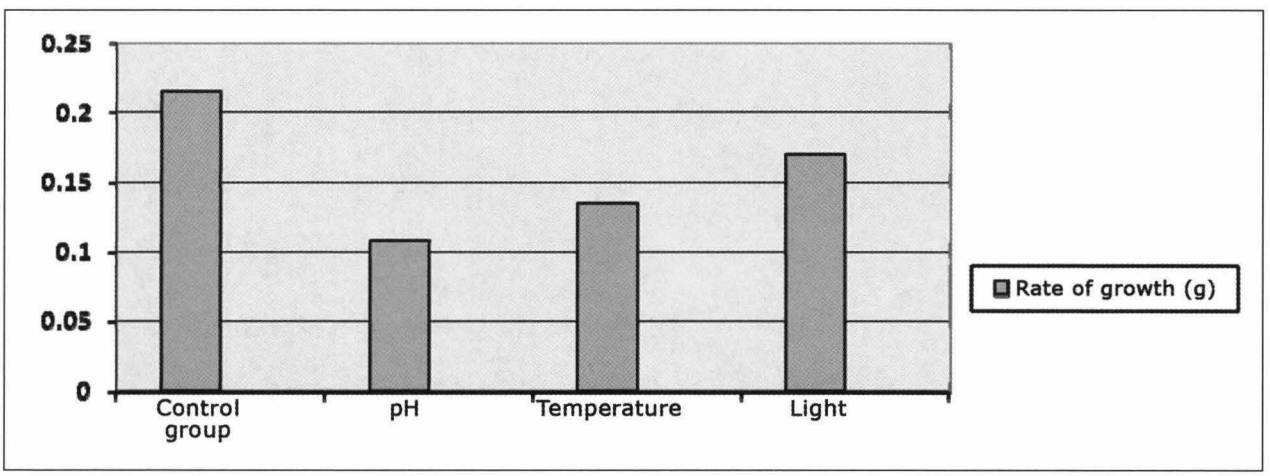


Figure 6. The growth rate recorded for *Ancistrus brevipinnis* (REGAN, 1904) reared under stressful factors.
Figura 6. Sporul de creştere înregistrat la specia *Ancistrus brevipinnis* (REGAN, 1904) supusă unor factori stresanţi.

REFERENCES

BOGATU D. & MUNTEANU GABRIELA 2003. *Tratat de ihtiopatologie*. Edit. Excelsior Art. Timişoara: 592, 595.
BREZEANU GH. 1972. *Hrana şi relaţiile trofice ale larvelor şi puilor de Stizostedion lucioperca (L.) în condiţii natural şi artificial-experimentale*. Buletin de Cercetări Piscicole. Bucureşti. **31**(3-4): 36, 40.
COCIU M. 1999. *Etologie – comportamentul animal*. Edit. Arta Grafică S. A. Bucureşti: 551, 523.
NELSON JOSEPH S. 2006. *Fishes of the World*. Fourth Edition. University Alberta. Canada. 456 pp.
OPREA M., RALEX C., RICARDO D. 2000. *Acvaristica practică*. Edit. Vocea României. Bucureşti: 25, 31.
ROŞCA I. D. 1977. *Fiziologie animală*. Edit. Didactică şi Pedagogică. Bucureşti. 157 pp.
SANDERS B. M. 1993. *Stress proteins in aquatic organisms: an environmental perspective*. Critical Reviews in Toxicology. Edit. Department of Biology, Molecular Ecology Institute, California State University, Long Beach, CA. **1**: 147-154.

SEGNER H. & VERRETH J. 1958. *Larviculture & Artemia Newsletter – Histological and biochemical methods in nutrition studies with fish larvae.* Edit. Laboratory of Aquaculture & Artemia Reference Center Ghent University. 47 pp.

***. www.aqua-net.org 09.09.2009 (accesed to March, 2011).

***. www.aquarium-answer.com 11.01.2010 (accesed to March, 2011).

***. www.americanaquariumproducts.com 23.02.2011 (accesed to March, 2011).

Chiorean Adriana
Natural Science Museum, Aquarium Department
B-dl Elisabeta, No. 1, Constanţa, Romania
E-mail: adrianaacvariu@yahoo.com

Stăncioiu Soare
"Dunărea de Jos" University Galaţi, Romania
Str. Domnească, No. 47

Dumitrescu Elena, Alexandrov Laura
"Grigore Antipa" National Research Institute of Marine Development
B-dul Mamaia. No. 300, Constanţa, Romania
E-mail: laurenta05@yahoo.com

Received: March 24, 2011
Accepted: August 7, 2011

Ichthyophthirius multifiliis INFECTION AT *Carassius gibelio* FROM THE SMALL RESERVOIRS WITHIN THE PREAJBA VALLEY

GOGA Ionelia Claudia, TÎMBURESCU Constanţa

Abstract. The present paper renders aspects related to the ichthyophthiriosis provoked by the ciliate *Ichthyophthirius multifiliis* FOUCHET 1876, which was detected at crucian carp *Carassius gibelio* (BLOCH, 1782) in the 9th reservoir, in March 2011; this reservoir belongs to a string of 13 reservoirs built through the damming of the Preajba Valley. The specimens were sampled by means of sporadic fishing with fishing basket, fishing rod, and dip from the basin. Thus, we obtained the ichthyologic material necessary for parasitological studies as fish specimens displayed obvious disorders. The identification of the ectoparasite ciliate was (microscopically) performed on the base of the clinical symptoms and microscopic examination of skin scrapings at the stereomicroscope and optical microscope, in the parasitological laboratory of Dolj Sanitary Veterinary Directorate.

Keywords: Preajba Valley, small basins, ciliate, ichthyophthiriosis.

Rezumat. Infecţia cu *Ichthyophthirius multifiliis* la *Carassius gibelio* din lacurile mici de baraj din bazinul Preajba. Lucrarea prezintă ihtioftirioza, o ectoparazitoză cosmopolită provocată de ciliatul *Ichthyophthirius multifiliis* FOUCHET, 1876, depistată la caras *Carassius gibelio* (BLOCH, 1782) în luna martie 2011, în lacul de baraj IX, aparţinând salbei de 13 lacuri formate prin bararea râului Valea Preajba. Probele au fost prelevate prin pescuiri sporadice cu setca, undiţa şi ciorpacul din lac, în scopul obţinerii materialului ihtiologic necesar cercetărilor parazitologice, peştii manifestând tulburări vizibile. Identificarea ectoparazitului s-a făcut macroscopic, prin examen clinic, şi microscopic, prin studierea raclatului tegumentar, la stereomicroscop şi microscopul optic, în cadrul laboratorului de parazitologie al Direcţiei Sanitar Veterinare Dolj.

Cuvinte cheie: Valea Preajba, lacuri mici de baraj, ciliat, ihtioftirioză.

INTRODUCTION

In 2009, there were initiated research studies in the area of a string of 13 reservoirs located along the Preajba Valley (Dolj County), the purpose of which was to establish the amount of the fish population present in the small basins, as well as to identify possible fish parasites (GOGA, 2009, 2009a; GOGA, 2010). Between 1999 and 2002, there were published data regarding the hydrobiological particularities of certain small eutrophic reservoirs located within the Jiu River hydrographical basin (CIOBOIU, 1999; CIOBOIU & BREZEANU, 2002).

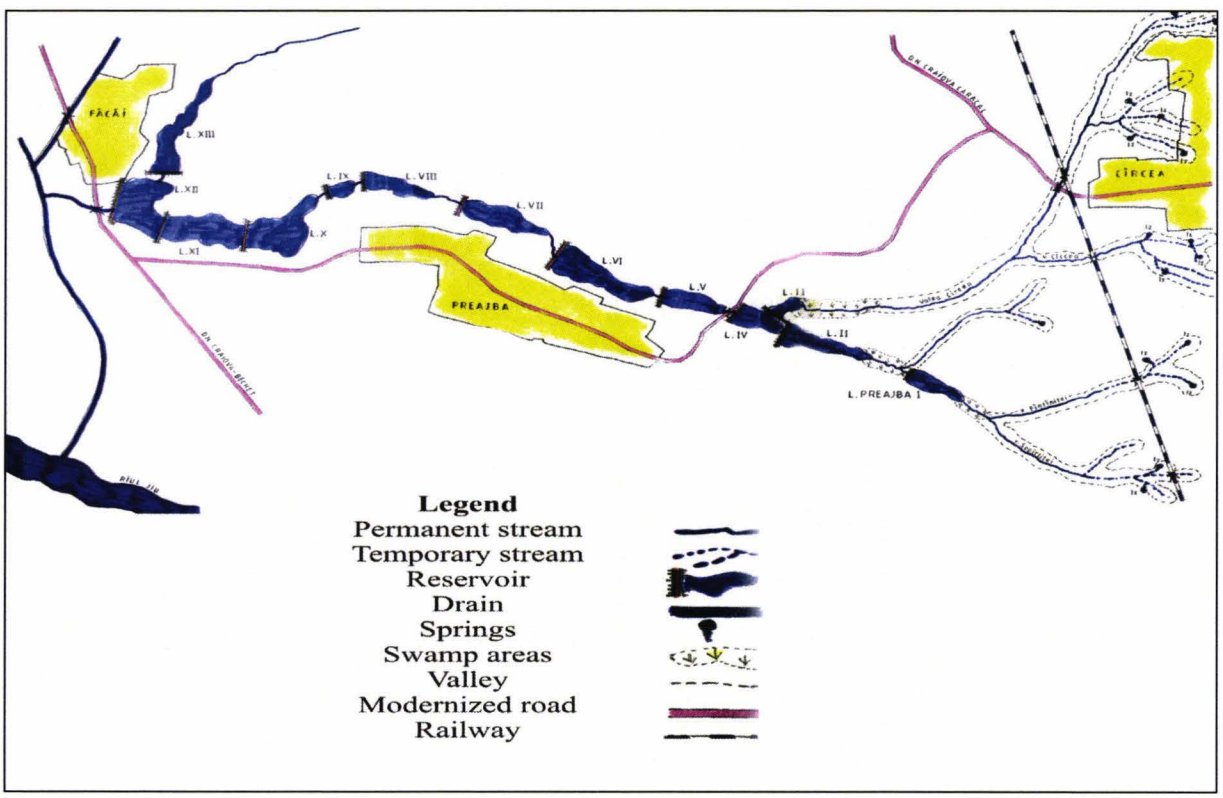


Figure 1. Map rendering the location of the reservoirs. / Figura 1. Harta cu amplasarea în zonă a lacurilor (CIOBOIU, 1999).

Ichthyophthirius multifiliis is an ectoparasite ciliate protozoan that affects numerous fresh water fish species living in stagnant waters or aquariums, no matter their age, and provokes a disease called ichthyophthiriosis. Clinically, the protozoan disease is emphasized by the appearance of some small whitish nodules on the tegument and fins (Fig. 2) and this is why the disease is also known as "white spot disease" (freshwater "Ich"). The parasite undergoes three developmental stages: trophozoite (adult feeding stage), tomont (resistant form, encapsulated dividing stage) and tomite (young, free swimming infective stage).

The aim of the present study was to describe this most common disease to infest freshwater fish, which we found at some specimens of *Carassius gibelio* caught in one of the reservoirs from the Preajba Valley. When describing the disease, we aimed at rendering its ethology and pathology, as well as prophylaxis and treatment measures known from the literature in the field.

Figure 2. Stereomicroscope view of the nodules with semolina grains aspect at the crucian carp *Carassius gibelio* infested with *Ichthyophthirius multifiliis* (Photo: Claudia Goga). / Figura 2. Vizualizarea la stereomicroscop a nodulilor cu aspect de boabe de griş la caras *Carassius gibelio* infestat cu *Ichthyophthirius multifiliis*.

Figure 3. Nodules on the tegument of a crucian carp *Carassius gibelio* infested with *Ichthyophthirius multifiliis* (Photo: Claudia Goga). / Figura 3. Noduli pe tegument la caras *Carassius gibelio* infestat cu *Ichthyophthirius multifiliis*.

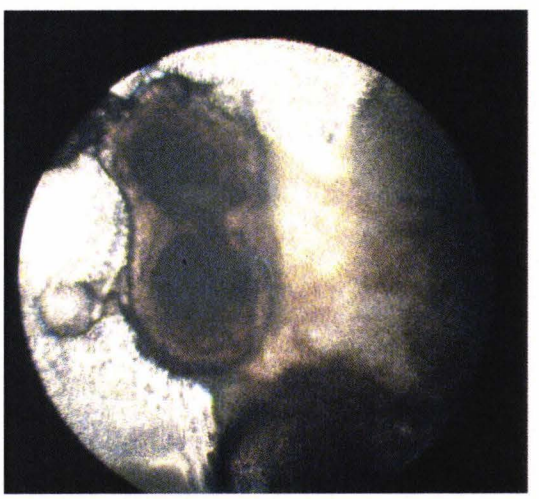


Figure 4. *Ichthyophthirius multifiliis* viewed at the optic microscope during the division process (Photo: Claudia Goga). / Figura 4. *Ichthyophthirius multifiliis* vizualizat la microscopul optic în procesul de diviziune.

MATERIAL AND METHODS

In March 2011, there were sampled specimens representing ichthyologic material from the 13 reservoirs built through the damming of the Preajba Valley River. Many fish species were sampled with the fishing rod and basket from these reservoirs. The ichthyologic material was determined from the taxonomic viewpoint (BĂNĂRESCU, 1964). The 12 species fished in the area belong to two orders and four families (Table 1).

Table 1. Fish species from the reservoirs.
Tabel 1. Speciile de peşti din lacurile de baraj.

Order	Family	Species
Cypriniformes	Cyprinidae	*Cyprinus carpio* LINNAEUS, 1758
		Carassius gibelio (BLOCH, 1782)
		Alburnus alburnus (LINNAEUS, 1758)
		Pseudorasbora parva (TEMMINK & SCHLEGEL, 1848)
		Rutilus rutilus (LINNAEUS, 1758)
		Scardinius erythrophthalmus (LINNAEUS, 1758)
		Abramis brama (LINNAEUS, 1758)
	Cobitidae	*Cobitis taenia* LINNAEUS, 1758
		Misgurnus fossilis (LINNAEUS, 1758)
Perciformes	Percidae	*Perca fluviatilis* LINNAEUS, 1758
		Sander lucioperca (LINNAEUS, 1758)
	Centrarchidae	*Lepomis gibbosus* (LINNAEUS, 1758)

Of these 12 species, ten are autochthonous and two are allochthonous acclimatized species (top mouth gudgeon and pumpkinseed) (OŢEL, 2007).

At ten crucian carp specimens from the 9th reservoir (Fig. 1) it was found the "white spot disease" and the ectoparasite ciliated protozoan *Ichthyophthirius multifiliis* was identified.

The examination started with the direct study of the whitish formations with the magnifying and binocular glass. Strictly referring to the parasitological examination, we emphasize that it was achieved for the identification of ecto- and endoparasites following the usual methods that are generally accepted in ichthyoparasitology (MUNTEANU & BOGATU, 2008). The identification of the ectoparasite was achieved on the basis of the general methods of ichthyoparasitological diagnosis, namely macroscopically by means of clinical examination (Fig. 3) and microscopically by means of tegument and fins scrapings, as well as through successive washing of the gills and tegument and view at the optic microscope and stereomicroscope, in the parasitological laboratory of Dolj SVD. At the same time, we preserved the protozoan in containers with 4% formalin (Fig. 5).

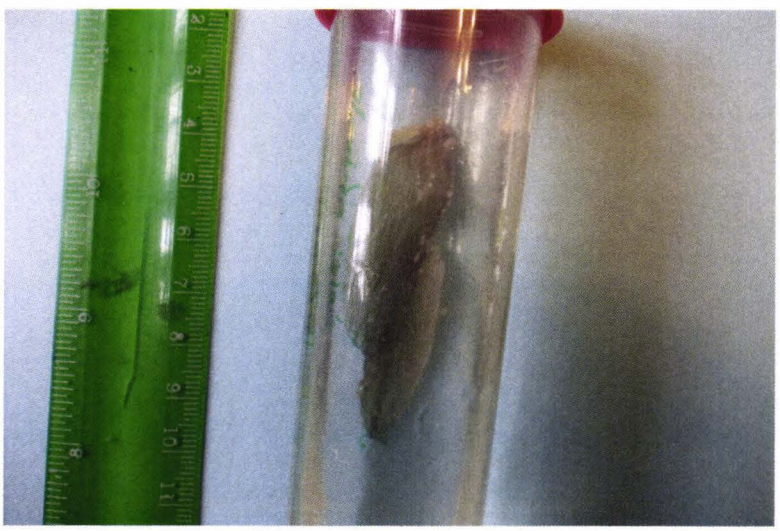


Figure 5. Preservation of the protozoan ciliate in a 4% formalin container (Photo: Claudia Goga). / Figura 5. Conservarea protozoarului ciliat în recipient cu formol 4%.

RESULTS AND DISCUSSIONS

Ichthyophthiriosis, also named "semolina stains disease" or "white spot disease", is a severe parasitosis. The oval protozoan covered by short uniform cilia was detected on the tegument and fins of the crucian carp; the nodules were disposed uniformly in the shape of meridians. The pathogen action of the parasite is mechanical, irritating, and despoliating. They feed on cellular detritus and, sometimes, even on erythrocytes.

As disease, it was diagnosed in March 2011 at the crucian carp in the 9th reservoir of the Preajba Valley. Thus, the whitish punctiform nodules of 0.5-1 mm in diameter were mainly spread on the fins and operculum and less on the body; the fish specimens did not have necrotic hotbeds, but they swam heavily at the surface of the water and disturbances were obvious. In case of massive invasions, especially at young fish populations, disturbances are obvious and severe. Fish receptivity to the invasion of *Ichthyophthirius* also depends on the amount of dissolved oxygen. Its decrease (to 3mg/l) induces physiological changes in the organism characteristic to a stress stage, which will surely lead to the decrease of the specimen resistance to the attack of this parasite (VULPE, 2007).

Ichthyophthiriosis appears during all seasons, when water temperature is between 3 and 28°C; however, the maximum intensity is registered during summer, when the parasite rapidly multiplies (OȚEL & CONSTANTIN, 1989).

The infestation of the crucian carp was induced by infesting tomites resulted from the division of the parasite that was previously encysted on different substrata from the water. Once they reach the tegument and fins, they feed on the provoked desquamations during the entire growing period, up to the trophont stage, displaying the aspect of semolina grains on the parasitized tissues and forming small cavities. After the microscopic examination, it was established that the protozoan was at the beginning of its biological cycle, as cysts were undergoing the phase of successive division (Fig. 4). After about 15 days of feeding, adult parasites reach 1mm, become mature and detach from the host body, fall into water and, in a few hours, they transform into cysts in different substrata, thus reaching the resistant, namely the tomont stage.

It is hard to fight against the disease; the prophylactic measures recommended for its prevention by the literature in the field are: compulsory quarantine of the material destined to populate reservoirs, preventive washing in an anti-parasite solution, ensuring an optimum population density, parasitological examination of fish at short time intervals.

The measures recommended by the literature in the field (MUNTEANU & BOGATU, 2008) for fighting against ichthyophthiriosis are: destruction of free swimming stages (tomites) through repeated administration, directly into water, of malachite green in a concentration of 0.1 mg/l water, intensification of the water current within infested basins, as well as reduction of the population density.

CONCLUSIONS

Even if the literature in the field mentions that ichthyophthiriosis appears at numerous fresh water fish species, the investigations developed in the 13 reservoirs allowed the diagnosis of the disease in the 9th reservoir at a single species belonging to Cyprinidae family, namely the crucian carp. The disease appears more often at stagnophil fish species and rarely at reophile species, because they move permanently, fish density is lower and motion may prevent the fastening of tomites and formation of trophonts. Stress may favour the infection with *Ichthyophthirius multifiliis*, as it leads to the decrease of resistance and of the reaction capacity of the body; the disease may evolve rapidly leading even to mortality before the appearance of the characteristic nodules, only a mucus hyper secretion signalling it.

The parasitological control of the disease is difficult to be performed by medicines. It was observed that the treatment with malachite green 2-3 g / 10m^3 water in solution directly dispersed in the infested reservoirs, with a time exposure of 7 h, which also supposes to stop the water current and to ensure aeration, is quite hard to be applied due to its increased toxicity. In severe situations, the treatment is repeated three times in 24 hours.

REFERENCES

BĂNĂRESCU P. 1964. *Fauna R.. P. R. Pisces, Osteichthyes*. Edit. Academia R.P.R. Bucureşti: 292-670.

CIOBOIU OLIVIA. 1999. *Lacurile mici de baraj din Câmpia Olteniei-particularități ecologice*. Museum. Muzeul Olteniei. Craiova: 16.

CIOBOIU OLIVIA & BREZEANU GH. 2002. *Particularitățile hidrobiologice ale unor lacuri mici de baraj eutrofe din bazinul hidrografic al Jiului*. Conferința Internațională IAD. Tulcea. România: 275-287.

GOGA IONELIA CLAUDIA. 2009. *Boli parazitare semnalate la peștii dulcicoli din bazinul hidrografic Valea Preajba*. Diversitatea, valorificarea rațională și protecția lumii animale. Edit. Știința. Moldova. Chișinău: 256-260.

GOGA IONELIA CLAUDIA. 2009a. *Basic data on the piscicultural communities from the hydrographic basin Preajba Valley. Conferința Internațională*. Oltenia. Studii și comunicări. Științele Naturii. Muzeul Olteniei Craiova. **25**: 165-169.

GOGA IONELIA CLAUDIA. 2010. *The mycosis generated by Saprolegnia parasitica in the fresh – water fish of the Cyprinidae family*. Oltenia. Studii și comunicări. Științele Naturii. Muzeul Olteniei Craiova. **26**(2): 161-164.

MUNTEANU GABRIELA & BOGATU D. 2008. *Tratat de ihtiopatologie*. Edit. Excelsior Art. Timisoara: 242-272.

OȚEL V. 2007. *Atlasul peștilor din rezervația biosferei Delta Dunării*. Centrul de informare tehnologică Delta Dunării. Tulcea: 183-382.

OȚEL V. & CONSTANTIN GH. 1989. *Ghid ihtiopatologic pentru piscicultura din Delta Dunării*. Edit. Bucureștii Noi. București: 115-135.

VULPE V. 2007. *Paraziți și parazitoze ale peștilor dulcicoli*. Edit. Stef. Iași: 169-171.

Goga Ionelia Claudia
The Oltenia Museum, Nature Sciences
Str. Popa Șapcă, No. 8, 200422, Romania
E-mail: ioneliagoga@yahoo.com
Tîmburescu Constanța
L.S.V.S.A Sanitary Veterinary Direction Dolj, Craiova, Romania
E-mail: ctimburescu@yahoo.co.uk

Received: March 24, 2011
Accepted: August 2, 2011

RESEARCH ABOUT DÂRMĂNEŞTI VILLAGE ORNITHOFAUNA (ARGEŞ COUNTY, ROMANIA)

MESTECĂNEANU Adrian

Abstract. During 2009, through monthly monitoring of the avifauna from the built-up areas of Dârmăneşti village located in the hilly area of the Râul Doamnei hydrographical basin, 33 species of birds (belonging to 3 orders) were identified, most of them being residents or summer visitors. 20 species were breeding species; *Passer domesticus* and *Streptopelia decaocto* have had the biggest densities of them. Also, *Passer domesticus* and *Streptopelia decaocto* have had the biggest values regarding the constancy, the dominance and the Dzuba index of ecological significance. During the considered period, the Passeriformes order was always overdominant.

Keywords: ornithofauna, bird activities, built-up areas, Dârmăneşti, Argeş.

Rezumat. Cercetări despre ornitofauna satului Dârmăneşti (judeţul Argeş, România). În anul 2009, prin monitorizări lunare ale avifaunei din zona intravilană a satului Dârmăneşti din zona deluroasă a bazinului hidrografic Râul Doamnei au fost identificate 33 de specii de păsări (aparţinând la trei ordine), majoritatea fiind sedentare sau oaspeţi de vară. 20 de specii au fost clocitoare, *Passer domesticus* şi *Streptopelia decaocto* având dintre ele densităţile cele mai mari. *Passer domesticus* şi *Streptopelia decaocto* au avut şi cele mai mari valori în ceea ce priveşte constanţa, dominanţa şi indicele de semnificaţie ecologică Dzuba. Ordinul Passeriformes a fost întotdeauna supradominant.

Cuvinte cheie: ornitofauna, activitatea păsărilor, intravilan, Dârmăneşti, Argeş.

INTRODUCTION

Research studies regarding the rural settlements avifauna were rarely done at the national level (MUNTEANU, 2000; RANG, 2002; MESTECĂNEANU, 2006; BĂLESCU, 2009 etc.). The reason of this paper is that no comparable study-researches have been performed in the hydrographical basin of the Râul Doamnei, until now. As Dârmăneşti is a typical village of the hilly area, it is probable that its avifauna is similarly to the one of other villages from neighbourhood. The avifauna of the locality is heterogeneous but I focused here only on that from the built-up areas because one of the other habitats will be the subject of the other studies.

MATERIAL AND METHODS

Dârmăneşti village belongs to the locality with the same name, which is situated at ca. 350 m height, in the hilly area, on the Râul Doamnei Valley (Argeş County). It is crossed by the road that links the localities Piteşti and Domneşti. Eastwards there is the hill (541 m maximum height) that separates the Râul Doamnei Valley from the Bratia Valley. Westwards there is the Râul Doamnei Floodplain, with a height of 325 - 344 m. There are orchards and gardens on the sides of the built-up areas – principally, plum trees (*Prunus domestica*), apple trees (*Malus pumila*), and pear trees (*Pyrus communis*), vegetables (*Brassica oleracea*, *Capsicum annuum*, *Solanum lycopersicum*, *Solanum tuberosum*, *Phaseolus vulgaris*, *Allium cepa*, *Daucus carota*, etc.), cereals and fodder plants (*Zea mays*, *Trifolium pratense*, *Medicago sativa*, etc.). The hill is covered with plum and apple orchards, in the lower zone, and with deciduous forest (*Fagus sylvatica*, *Carpinus betulus* and *Quercus* sp.), in the upper one. The floodplain is mainly cultivated with cereals and fodder plants (*Triticum durum*, *Zea mays*, *Trifolium pratense*, *Medicago sativa*, etc.) (Fig. 1).

The observations were performed in 2009, only in the built-up areas, in the morning, when the birds had their maximum activity. One sample was done each month. I used the method of the transect. The track was 1 km long, on the main road of the locality (Fig. 1). The species were visually and auditory identified (by BRUUN et al., 1999). A binocular 10x50 was employed.

RESULTS AND DISCUSSIONS

In the built-up areas from Dârmăneşti village, during 2009, 33 birds species were identified – 8.64% of the species from Romania (MUNTEANU, 1998), that belong to 3 orders and 27 families (Table 1). The list of birds can be larger. Thus, in the previous years, I also observed: *Ardea cinerea*, *Ciconia ciconia*, *C. nigra*, *Anser anser*, *A. albifrons*, *Anas platyrhynchos*, *Aquila chrysaetos*, *A. pomarina*, *A. clanga*, *Circaetus gallicus*, *Buteo buteo*, *Pernis apivorus*, *Accipiter gentilis*, *A. nisus*, *Milvus migrans*, *Circus aeruginosus*, *C. cyaneus*, *C. pygargus*, *Falco peregrinus*, *F. subbuteo*, *F. vespertinus*, *F. tinnunculus*, *Phasianus colchicus*, *Grus grus*, *Columba oenas*, *C. palumbus*, *Streptopelia turtur*, *Cuculus canorus*, *Athene noctua*, *Strix aluco*, *Apus apus*, *A. melba*, *Merops apiaster*, *Upupa epops*, *Picus canus*, *Dendrocopos syriacus*, *D. medius*, *Galerida cristata*, *Alauda arvensis*, *Lullula arborea*, *Anthus trivialis*, *A. spinoletta*, *Motacilla cinerea*, *Lanius collurio*, *L. excubitor*, *Nucifraga caryocatactes*, *Corvus monedula*, *C. frugilegus*, *C. corone cornix*, *Acrocephalus schoenobaenus*, *Regulus regulus*, *R. ignicapillus*, *Ficedula albicollis*, *Phoenicurus phoenicurus*,

Erithacus rubecula, *Turdus torquatus*, *T. viscivorus*, *T. pilaris*, *Parus lugubris*, *Certhia familiaris*, *Fringilla montifringilla*, *Serinus serinus*, *Carduelis chloris*, *C. spinus*, *Loxia curvirostra*, *Emberiza citrinella*, etc., some of them as breeding species (*Athene noctua*, *Lanius collurio*, *Phoenicurus phoenicurus*, *Erithacus rubecula*, *Serinus serinus*, etc.), other in search of food (*Buteo buteo*, *Accipiter gentilis*, *A. nisus*, *Falco subbuteo*, *Corvus corone cornix*, etc.), and others only in migration (*Ciconia ciconia*, *Anser anser*, *A. albifrons*, *Circus aeruginosus*, *C. pygargus*, *Falco vespertinus*, *Grus grus*, *Columba palumbus*, etc.). *Strix aluco*, *Regulus ignicapillus*, *Fringilla montifringilla*, *Carduelis spinus*, etc. were winter visitors. In majority, all these species were accidental species or very rare species.

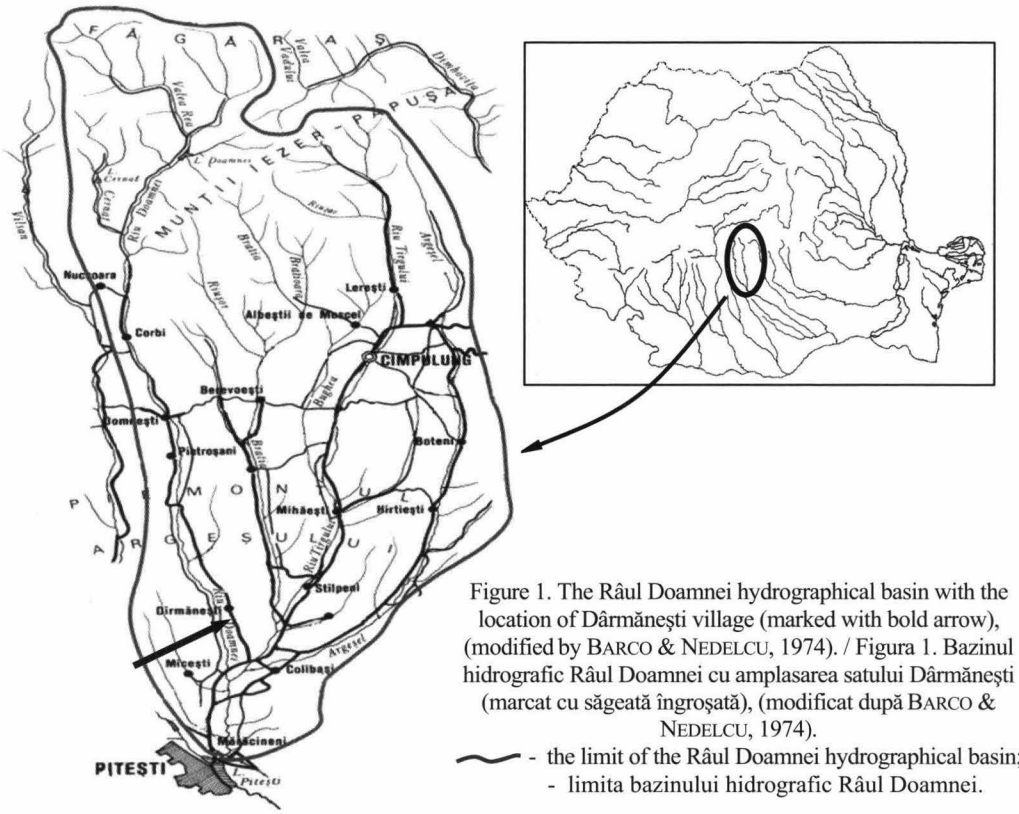


Figure 1. The Râul Doamnei hydrographical basin with the location of Dârmănești village (marked with bold arrow), (modified by BARCO & NEDELCU, 1974). / Figura 1. Bazinul hidrografic Râul Doamnei cu amplasarea satului Dârmănești (marcat cu săgeată îngroșată), (modificat după BARCO & NEDELCU, 1974).
~ - the limit of the Râul Doamnei hydrographical basin;
- limita bazinului hidrografic Râul Doamnei.

Comparatively, the avifauna of Stoenești locality, from Olt (an adjacent county of Argeș), during 2007 - 2009, numbered 93 species (but there were included all species observed in the perimeter of the locality: settlements, wetlands, agricultural areas, forests), (BĂLESCU, 2009). A part of the species identified at Dârmănești village during 2009 were observed in Stoenești, too (*Streptopelia decaocto*, *Picus viridis*, *Dendrocopos major*, *Hirundo rustica*, *Delichon urbica*, *Motacilla alba*, *Oriolus oriolus*, *Sturnus vulgaris*, *Garrulus glandarius*, *Pica pica*, *Troglodytes troglodytes*, *Sylvia atricapilla*, *Parus caeruleus*, *P. major*, *Passer domesticus*, *P. montanus*, *Fringilla coelebs* and *Carduelis carduelis*). I mention that the locality Stoenești is in the plain area and the village Dârmănești is in the hilly area.

On the other hand, within the built-up areas of the Piatra Craiului Mountains, during May - July (2004), 48 species of birds were identified (MESTECĂNEANU, 2006), more than double, relatively to the 22 species identified in Dârmănești in the same period of 2009. This diversity is the result of the various surrounding habitats and of the longer time of field observations. 28 species are common to both studies (*Picus viridis*, *Dendrocopos major*, *Hirundo rustica*, *Delichon urbica*, *Motacilla alba*, *Sturnus vulgaris*, *Garrulus glandarius*, *Pica pica*, *Troglodytes troglodytes*, *Sylvia atricapilla*, *S. curruca*, *Phylloscopus collybita*, *Phoenicurus ochruros*, *Turdus merula*, *T. philomelos*, *Parus palustris*, *P. caeruleus*, *P. ater*, *P. major*, *Aegithalos caudatus*, *Sitta europaea*, *Passer domesticus*, *P. montanus*, *Fringilla coelebs*, *Pyrrhula pyrrhula*, *Coccothraustes coccothraustes*, *Carduelis carduelis* and *Emberiza citrinella*).

In the hydrographical mountain basin of the Bistrița Moldovenească River (MUNTEANU, 2000), the anthropogenic avifauna (from villages and cities, alpine blanks, pastures and crops, gardens with fruit trees, hedges, abrupt banks, stagnant waters and coniferous plantations) comprised 150 bird species. Specific to the settlements were: *Ciconia ciconia*, *Streptopelia decaocto*, *Athene noctua*, *Apus apus*, *Dendrocopos major, D. syriacus*, *Hirundo rustica*, *Delichon urbica*, *Motacilla alba*, *Lanius collurio*, *Sturnus vulgaris*, *Corvus monedula*, *Sylvia curruca*, *Muscicapa striata*, *Phoenicurus ochruros*, *Turdus merula*, *Parus major, Passer domesticus*, *P. montanus*, *Coccothraustes coccothraustes*, *Fringilla coelebs, Serinus serinus*, *Carduelis chloris*, *C. carduelis*, etc.

The anthropogenic ecosystem of the middle basin of the Siret River sheltered 105 birds' species, many typical for human settlements: *Ciconia ciconia*, *Streptopelia decaocto*, *Athene noctua*, *Hirundo rustica*, *Delichon urbica*, *Passer domesticus*, etc. (RANG, 2002).

Table 1. The taxonomic distribution of the avifauna observed within the built-up areas of Dârmăneşti village, during 2009, comparatively with the situation at the national level. / Tabel 1. Distribuţia pe unităţi taxonomice a avifaunei observată în intravilanul satului Dârmăneşti în anul 2009, comparativ cu cea a ornitofaunei României.

Taxonomic unit	Romania	Dârmăneşti village	Weight (%)
Number of orders	19	3	15.79
Number of families	64	27	42.19
Number of species	382	33	8.64

Of the observed species (Table 2), regarding the phenology, 13 (39.39%) were resident (R), 1 (3.03%) was partial migratory (PM), 4 (12.12%) were winter visitors (WV), 10 (30.30%) were summer visitors (SV), 3 (9.09%) were species of passage (P) and 2 (6.06%) were accidental species (Ac). A species can belong to many phenological categories, but I took into consideration only their main category. The habitat provided the diet for the birds along the year, but preponderantly in its warm period, as suggested by the big percentage of the residents and summer visitors. However, the raised weight of the winter visitors shows that a series of birds found here good life conditions in this season. I mention that *Troglodytes troglodytes* and *Parus palustris* were considered winter visitors, despite the fact that, in other years, they were residents and *Parus ater* was catalogued as accidental bird, although, in other years, it was a frequent species.

The majority of the species (*Dendrocopos major, Sylvia curruca*, *Turdus philomelos*, *Parus palustris*, *Sitta europaea* etc.) have a diet that consists principally in insects and other small invertebrates and few species (*Pyrrhula pyrrhula* and *Carduelis carduelis*) are predominantly granivorous. Many species have a varied food, they being omnivorous (*Streptopelia decaocto*, *Garrulus glandarius*, *Passer domesticus*, *Coccothraustes coccothraustes*, etc.).

Table 2. The monthly occurrence of the bird species identified within the built-up areas of Dârmăneşti village, during 2009, and their phenology. / Tabel 2. Prezenţa lunară în observaţii a speciilor de păsări identificate în intravilanul satului Dârmăneşti în anul 2009 şi fenologia acestora.

No.	Species	Month												Phenology in the studied area	Observations
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.		
1	*Streptopelia decaocto*	■	■	■	■	■	■	■	■	■	■	■	■	R	
2	*Picus viridis*								■					Ac	1 i., on August 8
3	*Dendrocopos major*	■	■			■		■	■				■	R	
4	*Dendrocopos minor*		■										■	WV	
5	*Hirundo rustica*				■	■	■	■	■					SV	
6	*Delichon urbica*						■	■	■					SV	
7	*Motacilla alba*					■	■	■						SV	
8	*Oriolus oriolus*				■	■	■	■						SV	
9	*Sturnus vulgaris*			■	■	■	■			■				SV	
10	*Garrulus glandarius*							■					■	R	
11	*Pica pica*	■		■	■		■		■	■		■		R	
12	*Corvus corax*								■			■		R	
13	*Troglodytes troglodytes*		■											WV	1 i., on February 8
14	*Prunella modularis*										■			P	
15	*Sylvia atricapilla*					■								SV	1 i., on May 31
16	*Sylvia curruca*				■		■							SV	
17	*Phylloscopus collybita*							■						SV	1 i., on July 11
18	*Phoenicurus ochruros*				■	■	■	■	■					SV	
19	*Turdus merula*		■			■	■				■			PM	
20	*Turdus philomelos*						■							SV	5 i., on June 27
21	*Parus palustris*		■											WV	1 i., on February 8
22	*Parus caeruleus*	■	■	■	■		■	■		■		■	■	R	
23	*Parus ater*									■				Ac	2 i., on September 12
24	*Parus major*	■	■	■	■	■	■	■	■	■	■	■	■	R	
25	*Aegithalos caudatus*								■					R	1 i., on August 8
26	*Sitta europaea*	■				■	■	■	■	■	■	■	■	R	
27	*Passer domesticus*	■	■	■	■	■	■	■	■	■	■	■	■	R	
28	*Passer montanus*		■	■	■	■	■	■		■	■		■	R	
29	*Fringilla coelebs*			■	■				■				■	P	
30	*Pyrrhula pyrrhula*												■	WV	6 i., on 13 December
31	*Coccothraustes coccothraustes*	■					■						■	R	
32	*Carduelis carduelis*				■			■	■	■		■	■	R	
33	*Emberiza citrinella*			■					■					P	

Legend: R – resident species, PM – partial migratory species, WV – winter visitors, SV – summer visitors, P – passage species, Ac – accidental species, i. – individual(s).

Legendă: R – specie sedentară, PM – specie parţial migratoare, WV – oaspeţi de iarnă, SV – oaspeţi de vară, P – specii de pasaj, Ac – specii accidentale, i. – specii individuale.

The monthly number of the registered species and the monthly number of the registered individuals confirm the fact stated at the phenology that the warm period of the year was the most favourable for the observed bird species. So, from April to August, the number of species was always over 10 and the number of the individuals was always over 63, with the maximum in June (17 species, respectively 165 individuals). December was noticeable, because then a significant increase of the species number and of the individuals observed number was recorded, due to the increasing of both the individuals' number of the present species and of the other species, especially, species of Fringillidae, that, used the existing food supply and then left (Tables 2 and 3).

Table 3. The monthly and general repartition of the species and observed individual number. / Tabel 3. Repartiția lunară și pe întreaga perioadă a anului 2009 a numărului de specii și de exemplare observate.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Period
Number of species	8	10	9	13	13	17	15	15	10	7	8	14	33
Number of individuals	40	77	63	64	126	165	141	97	60	54	46	113	1046

Because Dârmăneşti village is in the vicinity of the forest from the hilly area, the major part of the identified species are typical for the woodland (*Picus viridis*, *Dendrocopos major*, *D. minor*, *Oriolus oriolus*, *Sturnus vulgaris*, *Garrulus glandarius*, *Corvus corax*, *Troglodytes troglodytes*, *Prunella modularis*, *Sylvia atricapilla*, *S. curruca*, *Phylloscopus collybita*, *Turdus merula*, *T. philomelos*, *Parus palustris*, *P. caeruleus*, *P. ater*, *P. major*, *Aegithalos caudatus*, *Sitta europaea*, *Fringilla coelebs*, *Pyrrhula pyrrhula*, *Coccothraustes coccothraustes*, *Carduelis carduelis* and *Emberiza citrinella*). Only 5 species (*Streptopelia decaocto*, *Hirundo rustica*, *Delichon urbica*, *Passer domesticus,* and *Passer montanus*) are characteristic for human settlements. *Motacilla alba* lives in human settlements and on the shores of the waters, *Pica pica* in open areas with scattered trees, and *Phoenicurus ochruros* in rocky areas (RADU, 1984; MUNTEANU, 2000).

Streptopelia decaocto has had the biggest number of individuals in June (12 individuals) and the least number of individuals in October and November (1 individual), less than 4 observed individuals being in winter. *Hirundo rustica*, from April to August, when it was observed, has had the maximum number of observed individuals in August (18 individuals), in passage (because the main passage from September was not intercepted). Also, a secondary maximum was in June (14 individuals), because of the young birds appearance. In the case of *Passer domesticus*, the number of individuals varied more evidently, its minimum being in April (24 individuals) and its maximum in July (85 individuals, mainly, young birds) (Fig. 2). These variations of the individuals are approximated, because the birds are often hidden and cannot be correctly counted.

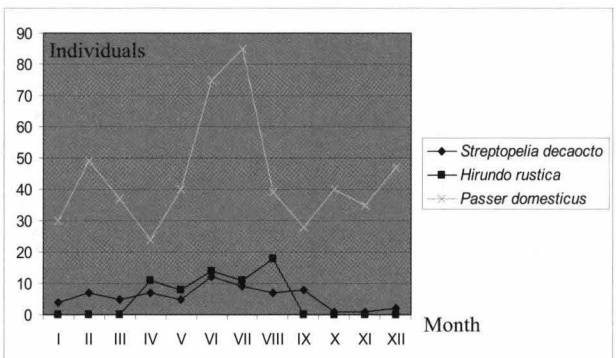


Figure 2. The monthly variation of the individuals number for some species of birds. / Figura 2. Variația lunară a efectivelor unor specii de păsări.

According to the methodology of the Atlas of the Romanian Breeding Birds (MUNTEANU et al., 2002), 20 species were breeding: 17 species (85%) – certainly breeding and 3 species (15%) – probably breeding. The biggest density was registered by *Passer domesticus* (2.16 pairs/ha). It was followed by: *Streptopelia decaocto* (0.50 pairs/ha), *Hirundo rustica* (0.36 pairs/ha), *Parus major* (0.35 pairs/ha), *Sturnus vulgaris* (0.30 pairs/ha), *Delichon urbica* (0.25 pairs/ha) and *Phoenicurus ochruros* (0.20 pairs/ha). The densities of the other species were smaller. The density of all species was 5.14 pairs/ha (Table 4).

Regarding the ecological indexes (Table 5), depending on the constancy, 3 species (9.09%, *Streptopelia decaocto*, *Parus major*, and *Passer domesticus*) were euconstant species (C4), 4 species (12.12%, *Pica pica*, *Parus caeruleus*, *Sitta europaea*, and *Passer montanus*) were constant species (C3), 8 species (24.24%, *Dendrocopos major*, *Hirundo rustica*, *Oriolus oriolus*, *Sturnus vulgaris*, etc.) were accessories species (C2) and 18 species (54.55%, *Picus viridis*, *Dendrocopos minor*, *Delichon urbica*, *Motacilla alba*, *Garrulus glandarius*, etc.) were accidental species (C1).

Depending on the dominance, 1 species (3.03%, *Passer domesticus*) was eudominant species (D5), 3 species (9.09%, *Streptopelia decaocto*, *Hirundo rustica*, and *Parus major*) were dominant species (D4), 6 species (18.18%, *Sturnus vulgaris*, *Parus caeruleus*, *Carduelis carduelis* etc.) were subdominant species (D3), 2 species (6.06%, *Turdus*

merula and *Fringilla coelebs*) were recedent species (D2) and 21 species (63.64%, *Troglodytes troglodytes*, *Turdus philomelos*, *Aegithalos caudatus*, *Coccothraustes coccothraustes*, *Emberiza citrinella*, etc.) were subrecedent species (D1).

Depending on the Dzuba index of ecological signification, 1 species (3.03%, *Passer domesticus*) was eudominant species (W5), 2 species (6.06%, *Streptopelia decaocto* and *Parus major*) were dominant species (W4), 6 species (18.18%, *Hirundo rustica*, *Sturnus vulgaris*, *Passer montanus*, etc.) were subdominant species (W3), 8 species (24.24%, *Oriolus oriolus*, *Pica pica*, *Phoenicurus ochruros*, *Fringilla coelebs*, etc.) were recedent species (W2) and 16 species (48.48%, *Picus viridis*, *Dendrocopos minor*, *Motacilla alba*, *Corvus corax*, *Prunella modularis*, *Parus ater*, etc.) were subrecedent species (W1).

Table 4. The densities of the breeding bird species observed during 2009 in Dârmăneşti village. / Tabel 4. Densitatea speciilor de păsări cuibăritoare observate în anul 2009 în satul Dârmăneşti.

No.	Species	Density (pairs/ha)	Breeding
1	*Streptopelia decaocto*	0.50	CB
2	*Dendrocopos major*	0.04	CB
3	*Hirundo rustica*	0.36	CB
4	*Delichon urbica*	0.25	CB
5	*Motacilla alba*	0.10	CB
6	*Oriolus oriolus*	0.06	CB
7	*Sturnus vulgaris*	0.30	CB
8	*Pica pica*	0.05	CB
9	*Sylvia atricapilla*	0.02	PB
10	*Sylvia curruca*	0.05	CB
11	*Phylloscopus collybita*	0.02	PB
12	*Phoenicurus ochruros*	0.20	CB
13	*Turdus merula*	0.13	CB
14	*Turdus philomelos*	0.10	PB
15	*Parus caeruleus*	0.11	CB
16	*Parus major*	0.35	CB
17	*Sitta europaea*	0.10	CB
18	*Passer domesticus*	2.16	CB
19	*Passer montanus*	0.16	CB
20	*Carduelis carduelis*	0.08	CB

Legend: CB – certainly breeding species, PB – probable breeding species.
Legendă: CB – specii clocitoare, PB – specii probabil clocitoare.

Table 5. The ecological indexes of the avifauna. / Tabel 5. Indicii ecologici ai avifaunei.

No.	Species	Constancy	Category of constancy	Dominance	Category of dominance	Dzuba index of ecological signification	Category of Dzuba index of ecological signification
1	*Streptopelia decaocto*	100.00	C4	6.50	D4	6.501	W4
2	*Picus viridis*	8.33	C1	0.10	D1	0.008	W1
3	*Dendrocopos major*	50.00	C2	0.86	D1	0.430	W2
4	*Dendrocopos minor*	16.67	C1	0.19	D1	0.032	W1
5	*Hirundo rustica*	41.67	C2	5.93	D4	2.470	W3
6	*Delichon urbica*	25.00	C1	1.05	D1	0.263	W2
7	*Motacilla alba*	25.00	C1	0.38	D1	0.096	W1
8	*Oriolus oriolus*	33.33	C2	0.57	D1	0.191	W2
9	*Sturnus vulgaris*	41.67	C2	4.88	D3	2.032	W3
10	*Garrulus glandarius*	16.67	C1	0.19	D1	0.032	W1
11	*Pica pica*	58.33	C3	1.05	D1	0.613	W2
12	*Corvus corax*	16.67	C1	0.19	D1	0.032	W1
13	*Troglodytes troglodytes*	8.33	C1	0.10	D1	0.008	W1
14	*Prunella modularis*	8.33	C1	0.19	D1	0.016	W1
15	*Sylvia atricapilla*	8.33	C1	0.10	D1	0.008	W1
16	*Sylvia curruca*	16.67	C1	0.19	D1	0.032	W1
17	*Phylloscopus collybita*	8.33	C1	0.10	D1	0.008	W1
18	*Phoenicurus ochruros*	41.67	C2	2.20	D3	0.916	W2
19	*Turdus merula*	41.67	C2	1.24	D2	0.518	W2
20	*Turdus philomelos*	8.33	C1	0.48	D1	0.040	W1
21	*Parus palustris*	8.33	C1	0.10	D1	0.008	W1
22	*Parus caeruleus*	75.00	C3	2.49	D3	1.864	W3
23	*Parus ater*	8.33	C1	0.19	D1	0.016	W1
24	*Parus major*	100.00	C4	9.08	D4	9.082	W4
25	*Aegithalos caudatus*	8.33	C1	0.10	D1	0.008	W1
26	*Sitta europaea*	75.00	C3	2.58	D3	1.936	W3

27	*Passer domesticus*	100.00	C4	50.57	D5	50.574	W5
28	*Passer montanus*	75.00	C3	3.06	D3	2.294	W3
29	*Fringilla coelebs*	33.33	C2	1.34	D2	0.446	W2
30	*Pyrrhula pyrrhula*	8.33	C1	0.57	D1	0.048	W1
31	*Coccothraustes coccothraustes*	25.00	C1	1.05	D1	0.263	W2
32	*Carduelis carduelis*	50.00	C2	2.20	D3	1.099	W3
33	*Emberiza citrinella*	16.67	C1	0.19	D1	0.032	W1

Legend: C1 - accidental species, C2 - accessory species, C3 - constant species, C4 - euconstant species; D1 - subrecedent species, D2 - recedent species, D3 - subdominant species, D4 - dominant species, D5 - eudominant species, W1 - subrecedent species, W2 - recedent species, W3 - subdominant species, W4 - dominant species, W5 - eudominant species.
Legendă: C1 - specii accidentale, C2 - specii accesorii, C3 - specie constantă, C4 – specie euconstantă, D1 - specie subrecedentă, D2 - specie recedentă, D3 - specie subdominantă, D4 - specie dominantă, D5 - specie eudominantă, 1 – specie subrecedentă, W2 - specie recedentă, W3 - specie subdominantă, W4 – specie dominantă, W5 - specie eudominantă.

The ecological diversity was small (2.04, respectively 3.60), the bird coenose being relatively unstable. The small values of evenness (0.58, respectively 0.11) show that the ecosystem was characterized by a great inequitability regarding the species distribution (Table 6). The differences between values consist in the fact that the Shannon-Wiener index takes in account both the number of species and the number of individuals of each species and the Simpson index takes in account the number of individuals of each species in relationship with the number of individuals of all observed species.

Table 6. The ecological diversity and the evenness of the avifauna observed in Dârmăneşti village. / Tabel 6. Diversitatea ecologică şi echitabilitatea avifaunei observată în satul Dârmăneşti.

Index	Shanon Wiener index	Hsmax	Shanon Wiener evenness	Simpson index (1/λ)	S	Simpson evenness
Value	2.04	3.50	0.58	3.60	34.04	0.11

I calculated the index of relation for all birds orders (KELEMEN & SZOMBATH, 1975; GACHE, 2002). The value of the static axis (As) is 33.33, and the value of the axis of dominancy (Ad) is 66.66.

Every season, the Passeriformes order was overdominant and the other orders were complementary (Table 7, Fig. 3). Considering the global participation of the orders to the coenose, again the Passeriformes order was overdominant and the other two orders (Ciconiiformes and Passeriformes) were complementary (Table 7, Fig. 4).

Table 7. The values of the index of relation of the bird orders identified in Dârmăneşti village, during 2009. / Tabel 7. Valorile indicelui de relaţie al ordinelor de păsări identificate în satul Dârmăneşti în anul 2009.

Orders	Prevernal	Vernal	Aestival	Serotinal	Autumnal	Hiemal	Period
Columbiformes	9.45	3.97	6.86	9.55	1.85	5.26	6.56
Piciformes	0.00	1.59	0.65	1.27	0.00	2.26	1.16
Passeriformes	90.55	94.44	92.48	89.17	98.15	92.48	92.28

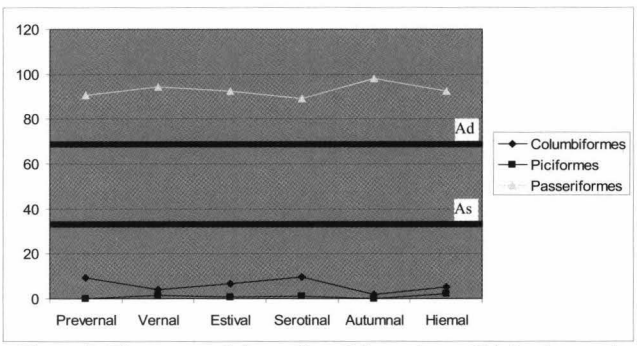


Figure 3. The seasonal dynamics of the orders of birds observed during 2009 in Dârmăneşti village. / Figura 3. Dinamica sezonieră a ordinelor de păsări observate în satul Dârmăneşti în anul 2009.

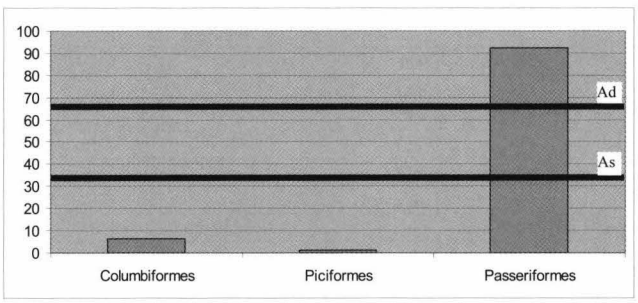


Figure 4. The global participation of the orders to the bird coenose observed during 2009 in Dârmăneşti village. / Figura 4. Participarea medie globală a ordinelor la populaţia de păsări observată în anul 2009 în satul Dârmăneşti.

CONCLUSIONS

The following conclusions can be drawn:

- during 2009, within the built-up areas of Dârmăneşti village, with a single field observation each month performed using the transect method on 1 km long track, 33 birds species were identified, but the list of species can be longer;

- in majority, the species were residents or summer visitors;
- most species and observed individuals were recorded in June; the least species were registered in October and the least number of individuals in January;
- the maximum of the individuals number for *Streptopelia decaocto* and *Passer domesticus* was in June, respectively July, after the young abandoned the nests; in the case of *Hirundo rustica*, the maxim was in August, in the passage period;
- 20 species were observed as breeding;
- *Passer domesticus* (2.16 pairs/ha) and *Streptopelia decaocto* (0.50 pairs/ha) had the bigger densities;
- the density: 5.14 pairs/ha for all birds;
- regarding the constancy, the dominance and the Dzuba index, the accidental species and the subrecedent species were preponderant;
- the ecological diversity of the birds was reduced, the ecosystem being characterised by a big unevenness regarding the distribution of the individuals per species;
- each period, the order Passeriformes was overdominant and the other orders were complementary.

REFERENCES

BARCO AURELIA & NEDELCU E. 1974. *Judeţul Argeş*. Edit. Academiei. Bucureşti: 3-20.

BĂLESCU CARMEN. 2009. *Preliminary studies regarding the bird fauna from Stoeneşti settlement – Olt County*. Analele Universităţii Craiova. Seria Biologie-Horticultură. Tehnologia prelucrării produselor agricole, Ingineria mediului. **14**(50): 407-412.

BRUUN B., DELIN H., SVENSSON L., SINGER A., ZETTERSTROM D., MUNTEANU D. 1999. *Păsările din România şi Europa. Determinator ilustrat*. Hamlyn Guide. Octopus Publishing Group Ltd.: 20-299.

GACHE CARMEN. 2002. *Dinamica avifaunei în bazinul râului Prut*. Publicaţiile Societăţii Ornitologice Române. Cluj-Napoca. **15**: 3-206.

KELEMEN A. & SZOMBATH Z. 1975. *Studiul fenodinamic al familiei Muscicapidaelor. I. Genul Sylvia, Muscicapa şi Phoenicurus*. Edit. Nymphaea. Muzeul Ţării Crişurilor. Oradea. **3**: 245-257.

MESTECANEANU A. 2006. *Researches on birds' density in Piatra Craiului National Park*. Research in Piatra Craiului National Park. Edit. Universităţii Transilvania. Braşov. **3**: 184-192.

MUNTEANU D. 1998. *Dicţionar poliglot al speciilor de păsări din România*. Publicaţiile Societăţii Ornitologice Române. Cluj Napoca. **6**: 8-50.

MUNTEANU D. 2000. *Avifauna bazinului montan al Bistriţei Moldoveneşti*. Edit. Alma Mater. Cluj-Napoca: 164-172.

MUNTEANU D., PAPADOPOL A., WEBER P. 2002. *Atlasul păsărilor clocitoare din România*. Publicaţiile Societăţii Ornitologice Române. Cluj-Napoca. **16**: 35.

RADU D. 1984. *Păsările în peisajele României*. Edit. Sport-Turism. Bucureşti: 166-168.

RANG C. P. 2002. *Studiul dinamicii unor comunităţi de păsări din bazinul mijlociu al râului Siret incluzând zonele lacurilor de acumulare*. Publicaţiile Societăţii Ornitologice Române. Cluj-Napoca. **13**: 147-151.

Mestecăneanu Adrian
Argeş County Museum, Street Armand Călinescu, No. 44
110047, Piteşti, Romania
E-mail: mestecaneanua@yahoo.com

Received: March 29, 2011
Accepted: August 8, 2011

MULTIANNUAL DYNAMICS OF SHREW (MAMMALIA, SORICOMORPHA, SORICIDAE) COMMUNITIES IN THE REPUBLIC OF MOLDOVA

NISTREANU Victoria

Abstract. The paper is based on the existing bibliographical data, on the collection of vertebrate animals of the Institute of Zoology of AŞM and on personal studies performed in the last years on the whole territory of Moldova. During the last 50 years considerable modification of shrew communities in various types of ecosystems on the whole territory of Moldova were registered. The most well adapted species is the common shrew, being dominant in the majority of the studied periods. The bicolour shrew, which was a rare, endangered species, introduced in the Red Book of Moldova, 2nd edition, became one of the most common among shrews in the last few years, while the Mediterranean water shrew that was one of the most abundant in the past century, at present became very rare, because of the pollution and transformation of wet and water habitats. The pygmy shrew is wide spread in various types of ecosystems, but its abundance is always below 25%. The lesser shrew is the most synanthropic species among shrews, its frequency in urban and rural area reaching 80%. The shrew species are good ecological indicators. Further measures on the protection of natural and water habitats must be taken.

Keywords: shrew, dynamics, natural and anthropogenic ecosystems.

Rezumat. Dinamica multianuală a comunităţilor de chiţcani (Mammalia, Soricomorpha, Soricidae) în Republica Moldova. Articolul are la bază datele bibliografice existente, colecţia de vertebrate terestre a Institutului de Zooogie al AŞM şi cercetările personale ale autorului efectuate pe tot teritoriul Moldovei în ultimii ani. Pe parcursul a 50 ani s-au înregistrat modificări considerabile ale comunităţilor de soricide în diverse tipuri de ecosisteme de pe tot teritoriul republicii. Cel mai bine adaptat este chiţcanul comun, care e dominant în majoritatea perioadelor studiate. Chiţcanul de câmp, care era o specie rară, periclitată şi introdusă în Cartea Roşie a Moldovei, ediţia a 2-a, în ultimii ani, iar chiţcanul de mlaştină, care era una din speciile cele mai abundente în secolul trecut, actualmente este foare rară din cauză poluării şi transformării habitatelor acvatice. Chiţcanul mic este larg răspândit în diverse tipuri de biotopuri, însă abundenţa acestuia nu depăşeşete 25%. Chiţcanul de grădină este cea mai sinantropă specie de chiţcani, frecvenţa ei în zonele urbane şi rurale atingând 80%. Speciile de chiţcani sunt buni indicatori ecologici şi sunt necesare măsuri de protecţie şi conservare a habitatelor naturale şi umede.

Cuvinte cheie: chiţcani, dinamică, ecosisteme naturale şi antropogene.

INTRODUCTION

Although the shrews are the smallest mammals of the world fauna, they have an important role in natural environment and in human economy, being an important link within the animal trophic chain. Five shrew species inhabit in Moldova: common shrew (*Sorex araneus*), pygmy shrew (*S. minutus*), bicolored white-toothed shrew (*Crocidura leucodon*), lesser shrew (*C. suaveolens*) and Mediterranean water shrew (*Neomys anomalus*). The water shrew (*N. fodiens*) was mentioned for the territory of Moldova by several researchers, but the detailed studies accomplished in the past century (AVERIN, 1969; CUCIUK, 1969; LOZAN, 1975, 1979) did not reveal the presence of this species. The presence of the species was mentioned in pellets of some predatory birds (GANEA & ZUBCOV, 1975; ZUBCOV, 1983).

In 60's – 70's of the past century the shrews were rather well studied. The most serious papers concerning the insectivore species in Moldova were published by LOZAN (1975, 1979), where it can be found data on morphology, ecology, palaeontology and spreading of shrews on the territory of Moldova. Also, some data concerning shrews can be found in other papers, where shrew species are mentioned (AVERIN, 1969a, 1969b, 1975; CUCIUK, 1969; LOZAN, 1969; ANISIMOV & COJUHARI, 1978; AVERIN et al., 1984; MUNTEANU & SAVIN, 1990; MIHAILENCO, 1996; MUNTEANU, 2005). After the 80's, the studies concerning this group of mammals were sporadic and incomplete, therefore their status in this period was uncertain. After 2000 shrew species were studies more completely from morphological, zoogeographical and ecological point of view (NISTREANU, 2007, 2008, 2009; NISTREANU et al., 2008, 2009; 2010). Also, in several papers shrew species are mentioned as components of small mammal communities in various types of ecosystems (TIKHONOV et al., 2009a, 2009b, 2010; TIKHONOVA et al., 2009; SAVIN et al., 2010). The paper contains information on multiannual dynamics of shrew communities in the last several decades on the territory of Moldova.

MATERIAL AND METHODS

The paper is based on the existing bibliographical data, on the collection of vertebrate animals of the Institute of Zoology of ASM and on personal studies performed in the last years on the whole territory of Moldova.

Shrews were caught with snap traps and fall traps in various types of ecosystems in the northern, central and southern parts of the republic. The individuals were determined, measured, weighed, sex, age, physiological and reproductive state were registered, the skulls were preserved for further morphological studies.

To characterize the biotopic distribution of the species the following indexes were considered: trappability $\mathbf{C_c=100n/C}$, where n – number of individuals, C – number of traps; the frequency **F= 100p/P,** where *P* – number of samples, p - samples where the species is present, and the species abundance **Ai = 100n/N**, where n – number of individuals of the species **i** in the sample, N – total individual number. To emphasize the position of certain species in a habitat the ecological significance was calculated (W_A) using the formula $\mathbf{W_a = F_a \cdot A_a/100}$, where F_a is frequency of the species and A_a – abundance index. The species with the significance lower than 1% in the studied biocoenoses are considered accidental; 1.1-5 % - accessorial; 5.1-10% – characteristic and W > 10% - constant for the given biocoenosis.

RESULTS AND DISCUSSIONS

During the last 50 years considerable modifications of shrew communities in various types of ecosystems on the whole territory of Moldova were registered. In the 1960's the dominant species among shrews in natural ecosystems of the republic was *S. araneus*, followed by *N. anomalus* that was very abundant in wet habitats (up to 25-30% in lower course of the Prut river). We have to mention than in 50's-60's of the past century the lower Prut area occupied large surfaces with many floating reed islet, covered with dense herbaceous vegetation and abundant litter. Here, the shrew species, especially the most hygrophilous ones (*S. araneus, S. minutus, N. anomalus*) could find favourable trophic and shelter conditions, therefore they were the dominant mammals in these biotopes (NISTREANU, 2007). The pigmy and lesser shrews were rather spread all over the studied territory, but their abundance was lower (Fig. 1). The bicolour shrew was rather rare and together with *C. suaveolens* was recorded in more arid biotopes, such as fields, pastures, abandoned lands, slopes with herbaceous or bush vegetation. The common, pigmy and Mediterranean water shrews have been recorded in various types of forest ecosystems, as well as in paludous and riparian biotopes (AVERIN, 1969; CUCIUK, 1969) with characteristic frequency. Shrew species were also recorded in pellets of predatory birds, but in very low quantity: *S. araneus* – between 0.6% and 2.4% from all the vertebrate prey, *S. minutus* – between 0 and 1.6%, *C. leucodon* – between 0.02% and 1.6%, *C. suaveolens* – between 0.3% and 1.9%. *N. anomalus* was not found in pellets, although its abundance among the small mammals was of 2.3% (ANISIMOV, 1969a, 1969b; LOZAN, 1969).

In the 1970's the most abundant species remained *S. araneus*, followed by *N. anomalus*. The proportion of common shrew among other shrew species was the highest in most of the ecosystems: forest (insular forests in the northern part, central forest, forest shelter belts), in meadows of the Nistru and the Prut rivers, in wet biotopes near woods. In insular woods of the northern part of the country, the common shrew constituted about 9-15% from all the small mammals, in wet oak forests with well-developed shrub and herbaceous vegetation its abundance reached 20%, while in the lower Prut marshes this species constituted up to 55% from all the small mammals (LOZAN, 1975, 1979). In the southern part of the republic, in the steppe zone, this species was very rare. In agricultural ecosystems, such as old orchards, forest shelter belts the density of the common shrew was rather low (3-4 individuals per 100 traps). The trappability index of the species was between 3% and 12% depending on the biotope (LOZAN, 1975).

The pigmy and lesser shrews were rather spread on the republic territory, but had low abundance, while *C. leucodon* was registered only in few natural ecosystems with very low abundance (fig. 1). The common shrew, both species of the genus *Crocidura* and *N. anomalus* were recorded as fauna components of cities and towns of Moldova (ANISIMOV & COUHARI, 1978). The Mediterranean water shrew was also rather spread, but mostly in wet biotopes, near various water sources. Its abundance in such biotopes reached about 30% from all the shrews. Together with the common shrew it constituted about 80% from the shrew population of the republic. The white-toothed shrew was represented only by few individuals recorded in "Codri" forest reserve. Its abundance did not overpass 2% from the shrew population. The pigmy and lesser white-toothed shrews had approximately the same frequency and constituted about 20% from the whole shrew population.

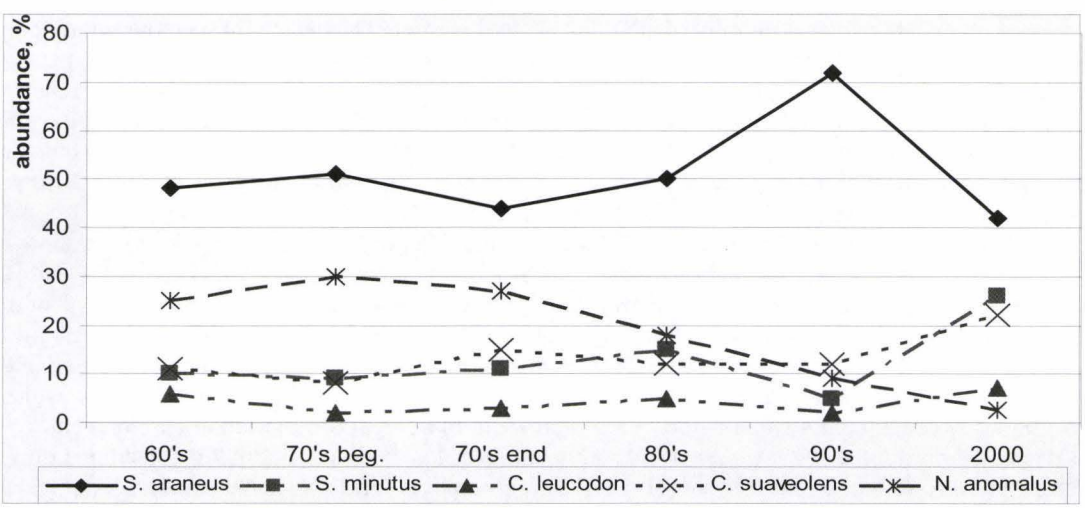


Figure 1. Dynamics of shrew community structure before 2000. / Figura 1. Dinamica comunităților de chițcani până în 2000.

In the pellets of owls the proportion of identified shrew remains among all the trophic resources constituted 0.31%-0.67% of *S. araneus*; 0.31% of *N. anomalus*, up to 1.14% of *C. suaveolens* (GANEA & ZUBCOV, 1975).

In the 1980's the abundance of common shrew was maintaining at high level and the species constituted more than half of the shrew population (Fig. 1). It was the only species among shrews that was recorded in forest shelter belts (MUNTEANU & SAVIN, 1990). In opposite, the Mediterranean water shrew dominance decreased below 20%, this species being common only in natural reserves in biotopes near water sources, while in the other ecosystems it became very rare. The abundance of pigmy shrew increased by about 10%, especially in "Codri" forest reserve in wet biotopes (AVERIN et al., 1984), but it still was rare on the republic territory. The abundance of white toothed shrews was very low, below 10% each species.

In 70's – beginning of 80's the trophic spectrum of predatory birds and owls was intensely studied (ZUBCOV, 1983). Thus, in the diet of *Buteo buteo* the frequency of shrew species related to the total prey species was the following: *N. fodiens* (0.4%-0.7%), *C. suaveolens* (0.7%); in *Falco tinnunculus* diet - *C. suaveolens* (0.4%-1.4%); in *Buteo lagopus* diet – *C. suaveolens* (1.4%-2.1%); in *Accipiter gentilis* diet – *S. araneus* (1.6%); in *A. nisus* diet – *Crocidura* sp. (1.4%); in *Asio otus* diet – *S. araneus* (0.1%-0.3%), *S. minutus* (0.1%-0.3%), *N. anomalus* (0.01%-0.02%), *C. suaveolens* (0.1%-0.8%), *C. leucodon* (0.1%-0.7%); in *Athene noctua* diet – *S. araneus* (0.1%-0.8%), *S. minutus* (0.1%-0.2%), *N. fodiens* (0.1%-0.4%), *N. anomalus* (0.1%), *C. suaveolens* (0.4%-0.9%); in *Strix aluco* diet - *S. araneus* (1.3%-4.8%), *S. minutus* (0.2%-0.7%), *N. anomalus* (1.2%-4.1%) and *C. suaveolens* (0.4%-0.9%).

In 1990's the changes of social and economic conditions led to the changes of ecosystem structure and to the modification of whole landscape of the Republic of Moldova. Vast single-crop agricultural fields from the agrarian complex of 70-80's that occupied large territories were divided in parcels cultivated with various annual, biannual and perennial cultures. Many lands were abandoned and uncultivated, the mosaicity of the territory increased. The process of natural habitat destruction (forest cutting, increasing of recreational activity, waste deposited outside localities, water habitat pollution etc.) was rather intense. In such stressful conditions the shrew species density decreased drastically compared with other mammal groups. In this period the common shrew showed high degree of adaptability and the largest limits of ecological valence. Thus, it had the highest abundance among soricid mammals and constituted almost 80% of the shrew population, being a constant species in many types of natural and anthropized ecosystems (MIHAILENCO, 1996). *S. minutus* and *N. anomalus* were characteristic in wet habitats and near water basins in natural reserves and protected areas, while in other habitats they were accidental or accessorial species. Their total abundance was rather low: the pigmy shrew constituted 5%, the Mediterranean water shrew – about 9%, the lesser white-toothed shrew – about 12%, while the white toothed shrew – only 1-2% (Fig. 1). The last species was very rare in the past century and since the 80's its number decreased more, so it was included in the Red Book of Moldova, 2nd edition as critically endangered. It can be also observed the strong decrease of the Mediterranean water shrew by more than three times in comparison with the 70's, conditioned by intense drying of the lower Prut and the Nistru swamp ecosystems in the 80's and by intense pollution of surface waters in 90's.

At the beginning of the new century many abandoned lands reverted to their more or less natural state as natural biotopes, such as pastures, meadows, grazing lands etc. At the same time, the processes of anthropization, urbanization and degradation of the natural ecosystems occur all over the territory of the republic. In this context the modification of the shrew community's structure continued. The common shrew remain the dominant species in the population, but its abundance decreased (to 43%) compared with the previous period. It is more tolerant to the environment conditions and to anthropogenic activity in comparison to other shrew species. The pigmy shrew had the abundance of above 30%. The density of bicolour white-toothed shrew increased up to 8%, while the abundance of *N. anomalus* decreased drastically to only 3% (Fig. 1).

Starting with 2003 regular and detailed studies of shrew communities were performed. The common shrew is the dominant species and was recorded in the majority of the studied natural and anthropogenic biotopes (F = 94%). The frequency of pigmy shrew was also rather high – 88%, but it is rarer. The density of bicolour white-toothed shrew increased and its frequency was rather high with the value of 9.7%, while in its preferred habitats the frequency of the species reaches 40%. The density of bicolour white-toothed shrew increased up to 8.8% and its frequency was rather high with the value of 9.7% while in its preferred habitats the frequency of the species reaches 42% (NISTREANU et al., 2008). The lesser shrew was more frequent (17.8%) and abundant. The Mediterranean water shrew was the rarest shrew among other species after 2000. Its frequency was very low (below 5%), being registered only near aquatic basins of natural reserves, and the maximum abundance of 7.8% (Fig. 2).

In the last years of study the structure of shrew communities on the territory of Moldova show significant changes (Fig. 2). In the majority of the study periods *S. araneus* is the dominant species, except 2004 and 2008, when its abundance is below 30%. The abundance of pigmy shrew is the highest in 2004 (more than 45%), than it maintains between 20% and 25% and decreases to 10% in 2009. The evolution of *C. leucodon* is very interesting: from rare species and 15% abundance it increases to 36% in 2009, being together with the common shrew the dominant species in the studied ecosystems. The lesser white-toothed shrew abundance also increased to 2008, when it was the dominant species. Its frequency constituted 40% in natural ecosystems and more than 85% in urban environment. *N. anomalus* abundance decreased during the last years; in 2008 it was not recorded at all and in 2009 it constituted only about 7% from all the shrews. The Mediterranean water shrew was registered as rare, accidental species. Its abundance in the

republic ecosystems decreased drastically in the last 20 years and it becomes a very rare and critically endangered species. This fact is caused by the degradation of wet habitats and by water basins pollution.

We have to mention the high abundance of bicolour white-toothed shrew in the last several years. It was recorded not only in natural and wet biotopes, but also in more arid ones and in agrocoenoses. In abandoned lands the species was even more abundant than the common shrew and its trappability index constituted 10% from all the small mammals.

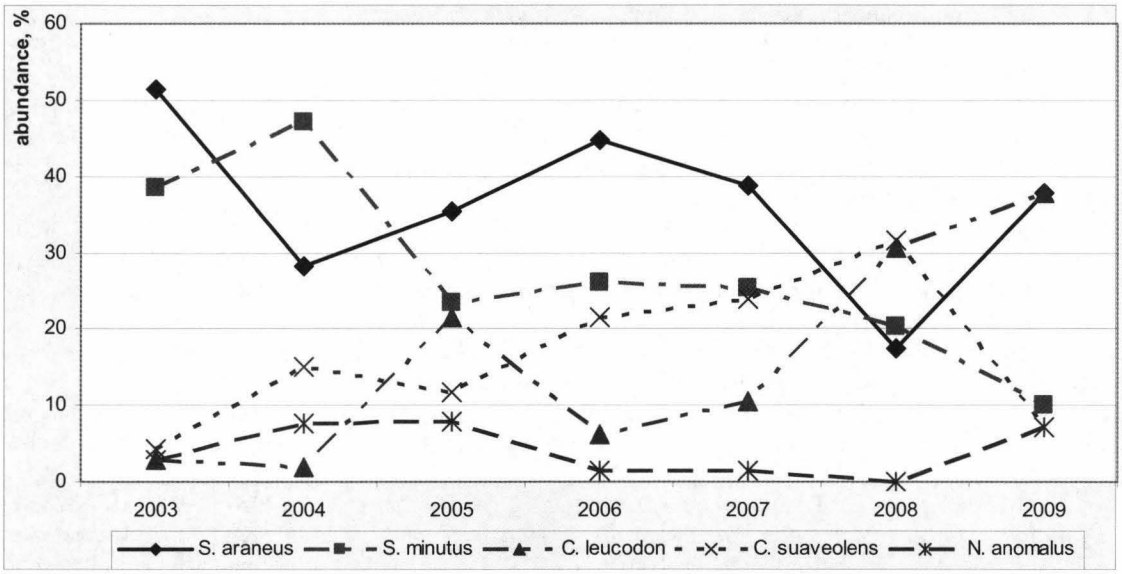


Figure 2. Multiannual dynamics of shrew communities in the last years of study. / Figura 2. Dinamica multianuală a comunităților de chițcani în ultimii ani de studio.

CONCLUSIONS

The structure of shrew community showed significant changes during the last decades. The most well adapted species is the common shrew, being dominant in the majority of the studied periods. The bicolour white-toothed shrew, which was a rare endangered species, introduced in the red Book of Moldova, became one of the most common among shrews in the last years. The Mediterranean water shrew that was one of the most abundant in the past century, at present became very rare, because of the pollution and transformation of wet and water habitats. The pygmy shrew is wide spread in various types of ecosystems, but its abundance is always below 25%. The lesser shrew is the most synanthropic species among shrews, its frequency in urban and rural area reaching 80%.

REFERENCES

ANISIMOV E. P. 1969a. *Materialy po letnemy pitaniyu ceroi neiasyti v Moldavii.* In Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **3**: 30-35. [In Russian].

ANISIMOV E. P. 1969b. *Factory opredeliayushchie dibychu ushastoi soby zimoi.* In Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **3**: 36-40. [In Russian]

ANISIMOV E. & COJUHARI A. A. 1978. *Fauna gorodov I ee ohrana.* Cartea Moldovenească. Chişinău. 56 pp. [In Russian].

AVERIN IU.V. 1969a. *Osnovnye compleksy covremennykh biotopov ptits I mlekopitaiyushchikh Moldavii.* In Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **4**: 3-14. [In Russian].

AVERIN IU. V. 1969b. *O pitanii obycnovennoi pustelgi v Moldavii.* In Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **4**: 21-25. [In Russian].

AVERIN IU. V. 1975. *Ptitsy I mlekopitaiyushchie zapovednica "Codri".* Ecologia ptits I mlekopitaiyushchikh Moldavii. Ştiinţa. Chişinău: 73-81. [In Russian].

AVERIN IU. V., MUNTEANU A. I., CHEGORCA P. T., GAVRILENCO V. S., LUNCASHU M. I., SAVIN A. I. 1984. *Mlekopitaiushchie. Priroda zapovednica "Codri".* Ştiinţa. Chişinău: 57-64. [In Russian].

CUCIUK A.V. 1969. *Mlekopitaiushchie plavnei nizoviev Pruta.* In Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **4**: 63-68. [In Russian].

GANEA I. M. & ZUBCOV N. I. 1975. *Pitanie domovogo sycha (Athene noctua Scop.) v srednei chasti Moldavii.* Ecologia ptits I mlekopitaiyushchikh Moldavii. Ştiinţa. Chişinău: 63-72. [In Russian].

LOZAN M. N. 1975. *Nasekomoyadnye mlecopitayushchie Moldavii (Insectivora, Mammalia).* In Ecologia ptits I mlekopitaiyushchikh Moldavii. Ştiinţa. Chişinău: 96-118. [In Russian].

LOZAN M. N. 1979. *Nasekomoyadnye. Mlecopitayushchie.* In Jivotnyi mir Moldavii. Ştiinţa. Chişinău: 25-40. [In Russian].

LOZAN M. N. 1969. *Osobennosti zimovki mlekopitaiyushchikh Dnestrovsco-Prutscogo mejdurechia.* Voprosy ecologii I practicheskogo znachenia ptits I mlekopitaiyushchikh. **3**: 61-79. [In Russian].

MUNTEANU A. I. & SAVIN A. I. 1990. *Mlecopitayushchie.* In Fauna biotsenoticheskih oazisov I ee practichescoe znachenie. Ştiinţa. Chişinău: 179-202. [In Russian].

MIHAILENCO A. 1996. *Gryzuny I nasekomoiadnye zapovednicov Moldovy.* Simpozion jubiliar "Rezervaţia naturală Codrii" – 25 ani. Realizări, probleme, perspective: 40-41. [In Russian].

MUNTEANU A. 2005. *Mamifere. Natura Rezervaţiei „Plaiul Fagului".* Chişinău: 244-265.

NISTREANU VICTORIA. 2007. *Soricidele (Soricidae, Insectivora) din colecţia muzeului Laboratorului Vertebrate Terestre al Institutului de zoologie al A.S.M.* VI Conf. of Zoologists of Moldova, Chişinău, Ştiinţa: 43-44.

NISTREANU VICTORIA. 2008. *Spreading of insectivore species (Erinaceidae, Talpidae, Soricidae, Insectivora) in Nistru river basin.* Transboundary Dniester river basin management and the EU Water Framework Directive. Proceedings of International Conference: 213-217.

NISTREANU VICTORIA, MUNTEANU A., SAVIN A., CARAMAN NATALIA, BENEŞ O., GHEORGHIŢĂ STELA, BURLACU VICTORIA, USPENSCAIA I. 2008. *Date preliminare privind răspândirea soricidelor (Soricidae, Insectivora) pe teritoriul Republicii Moldova.* Simpozion Internaţional consacrat jubileului de 60 de ani al academicianului Ion Toderaş. Chişinău: 68-70.

NISTREANU VICTORIA. 2009. *Spreading of shrews from genus Sorex on the territory of Republic of Moldova.* Annual Zoological Congress of "Grigore Antipa" Museum. Bucharest. Romania: 50.

NISTREANU VICTORIA, BURLACU VICTORIA, CARAMAN NATALIA. 2009. *Rasprostranenie belozuboc (Soricidae, Insectivora) na territorii Moldovy.* Actual problems of zoo and phylogeography of mammals. Penza: 60. [In Russian].

NISTREANU VICTORIA, SAVIN A., LARION ALINA, CORCIMARU N., BULRACU VICTORIA, CARAMAN NATALIA. 2010. *Evolution of shrew (Mammalia, Soricomorpha, Soricidae) communities in Republic of Moldova in the last decades.* Dniester river basin: ecological problems and management of transboundary natural resources: 148-150.

SAVIN A., NISTREANU VICTORIA, CORCIMARU N., LARION ALINA. 2010. *Diversity of mammal communities in the ecosystems from the central zone of the Republic of Moldova.* Oltenia. Studii şi comunicări. Ştiinţele Naturii. Muzeul Olteniei Craiova. **26**: 259-262.

TIKHONOV I. A., KOTENKOVA E. V., YSPENSKAIA I. G., CONOVALOV IU. N., BURLACU V. I., BENEŞ O. A., GHEORGHIŢA C. D., CARAMAN NATALIA, TIKHONOVA G. N., KHRYSTIN V. A., NISTREANU VICTORIA, MUNTEANU A. I. 2009. *Gryzuny I nasecomoyadnye nezastroennyh territorii g. Chisineva.* Proceedings of 4th International Scientific-Practical Conference "Urboecosystems: problems and Prospects of Development", Ishim: 310-315. [In Russian].

TIKHONOV I. A., MUNTEANU A. I., YSPENSKAIA I.G., CONOVALOV IU. N., BURLACU VICTORIA. I., BENEŞ O. A., GHEORGHIŢA C. D., CARAMAN NATALIA C., TIKHONOVA G. N., KHRYSTIN V. A., NISTREANU VICTORIA, KOTENKOVA E. V. 2009. *Vidovoe raznoobrazie melkih mlecopitayushchikh na primere g. Chişinău.* Geoecological and bioecological problems of northern Black Sea basin. Proceedings of IIIrd international conference. Tiraspol: 200-203. [In Russian].

TIKHONOVA G. N., TIKHONOV I. A., KOTENKOVA E. V., YSPENSKAIA I. G., CONOVALOV IU. N., BURLACU VICTORIA I., NISTREANU VICTORIA, BENEŞ O. A., GHEORGHIŢA C. D., CARAMAN NATALIA C., KHRYSTIN V. A., MUNTEANU A. I. 2009. *Sravnitelnyi analiz naseleniya melkih mlecopitayushchikh nezastroennyh territorii dvuh Ebropeiskih gorodov (Moskvy I Chişinău).* Diversitatea, valorificarea raţională şi protecţia lumii animale. Simpozion internaţional consacrat celei de-a 70-a aniversări din ziua naşterii profesorului universitar Andrei Munteanu. Chişinău. Ştiinţa. Moldova: 117-120. [In Russian].

TIKHONOV I. A., MUNTEANU A. I., YSPENSKAIA I. G., CONOVALOV IU. N., BURLACU VICTORIA, CARAMAN NATALIA, NISTREANU VICTORIA, TIKHONOVA G. N. 2010. *Biotopicheskoe raspredelenie, structura populiatsii i necotorye osobennosti razmnijenia melkih mlekopitaiushchikh g. Kishineva.* Povoljskii ekologicheskii jurnal. 4: 404-415. [In Russian].

ZUBCOV N. 1983. *Hishchnye ptitsy I sovy Moldavii.* Thesis of doctor of biology. Chişinău. 224 pp. (In Russian).

Nistreanu Victoria
Institute of Zoology of ASM
Str. Academiei, No.1, Chişinau, Moldova
E-mail: vicnistreanu@gmail.com

Received: March 29, 2011
Accepted: July 22, 2011

ETHOLOGICAL RELATIONS IN THE COMMUNITIES OF TWO SPECIES OF WOOD MICE *Apodemus uralensis* AND *Apodemus sylvaticus*

CEMIRTAN Nelli, NISTREANU Victoria, LARION Alina, SAVIN Anatol

Abstract. The identified complexes of the acquaintance, aggressive, protective (defensive), conflict, friendly, comfortable behaviour includes 22 elements, shown by wild mice in pair encounters. Intraspecific interactions in *Apodemus uralensis* populations are tenser than in *A. sylvaticus* populations, which is connected with the presence in males of the first species of well pronounced complex of aggressive behaviour. Generally, interspecific relations were peaceful: in *A. sylvaticus* male contacts, the elements of aggression were practically missing, while in *A. uralensis* males the number of attacks decreased by 4 times and of fights by 10 times in comparison with the intraspecific indexes. In female encounters, on the contrary, elements of aggression were revealed from both species, which were missing in intraspecific contacts.

Keywords: behaviour, *Apodemus uralensis, A. sylvaticus*, communities, males, females.

Rezumat. Interacţiunile etologice în comunităţile a două specii de şoareci de pădure *Apodemus uralensis* şi *Apodemus sylvaticus*. Complexele identificate de comportamente de familiarizare, agresivitate, apărare, conflict, confort includ 22 elemente, manifestate de şoareci în experienţele de aşezări în cuplu. Interacţiunile intraspecifice în populaţiile de *Apodemus uralensis* sunt mai tensionate decât în cele de *A. sylvaticus*, ceea ce este legat de prezenţa unui complex bine pronunţat de comportament agresiv la masculii primei specii. Interacţiunile interspecifice sunt, în general, paşnice: în interacţiunile masculilor de *A. sylvaticus* elementele agresive practice lipseau, iar la cei de *A. uralensis* numărul atacurilor a scăzut de 4 ori, cel al luptelor – de 10 ori în comparaţie cu indicii intraspecifici. În interacţiunile între femele, dimpotrivă, au fost înregistrate elemente agresive din partea ambelor specii, care lipseau în contactele intraspecifice.

Cuvinte cheie: comportament, *Apodemus uralensis, A. sylvaticus*, comunităţi, masculi, femele.

INTRODUCTION

The elaborate complex of animal behaviour in natural conditions represents a universal powerful population adaptation system, responsive to any changes of the external factors into their complex interplay (MANTEIFEL, 1987). Behavioural adaptation system is characterized by a relatively constant and at the same time, by its huge variability. Knowledge of the laws of the functioning of behavioural adaptation system is of great importance for the conservation of species diversity and equilibrium maintenance in species populations and communities in constantly changing conditions of their existence.

MATERIAL AND METHODS

The studies were accomplished on sexually mature individuals of *A. uralensis* (PALLAS, 1811) and *A. sylvaticus* (LINNAEUS, 1758) of both sexes, caught on experimental sectors of Sociteni village (Centre of R. Moldova) in different seasons of the year. In order to study the interspecific relations the standard methods were used: pair interactions on a neutral field (COIRNS & SCHOLZ, 1973; GOLTSMAN et al., 1977). To accomplish the task pairs of same age and weight were selected, interactions were studied between the same or different sexes. Several series of experiences were performed, during which the character of intraspecific and interspecific relations of males and females of the above mentioned species were studied. At the whole 85 pair encounters were performed with the participation of 46 males and 24 females.

RESULTS AND DISCUSSIONS

During the behaviour study of *A. uralensis* and *A. sylvaticus* the stereotyped behaviour of the animals was emphasized, as well as their species and sex peculiarities. At first the generalized description of the behaviour of animals in the experimental conditions will be given.

In the first minutes of activity in neutral field the animals intensely studied the new environment and the orientation-exploratory behaviour was one of the main ethological reactions within the total behaviour activity pattern. It was expressed in the free movements of the animals within the camera, sniffing, sometimes licking the corners, tactile activity, examination of the walls and floor.

After or during the exploration of the new environment followed the attempt of individuals to get familiarized with each another and the initiative of contact usually comes from one of the partners. At mutual interest in each other different types of olfactory contacts were registered: naso-nasal, naso-lateral, naso-dorsal, naso-ventral, and for mixed pairs there are particularly common naso-anal and naso-genital contacts (Fig. 1). The contact initiative could result in assault, fleeing of one of the partners, mutual friendly contact and peaceful separation of the individuals to "their own" corners.

Often passive staying of one or both animals in their corners was observed, peaceful sitting next to each other, self-grooming and partner grooming (allogrooming), sometimes mutual or alternately. In friendly contacts the animals stay together in the corner, climb above, under and over one another, often changing places.

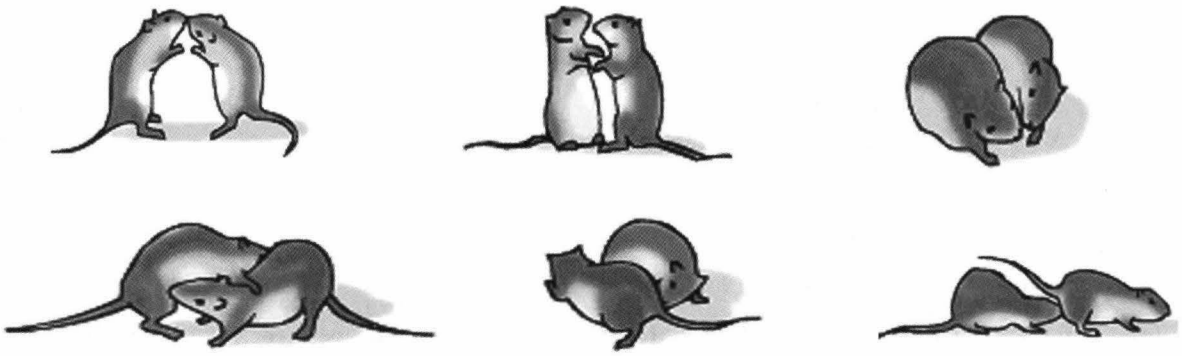


Figure 1. Various types of friendly contacts. / Figura 1. Diverse tipuri de contacte prietenoase.

Most varied were the elements connected with agonistic interactions, among which there can be mentioned attacks, fight, chase, escape without an attack and after it, winning the battles, pushing and boxing, aggressive stands (Fig. 2), squeaks, and sometimes it was registered active seizure of foreign territory (occupation). To this group interactions there can be also attributed avoiding contact with the partner, intense surveillance from the corner over the actions of the partner, as well as relations of domination-subordination, in which the subordinate animal lay on his back to avoid aggressive contact with the dominant, bowed his head in front of him, allow to climb on itself, to sit on top of itself or to be trampled by the dominant etc.

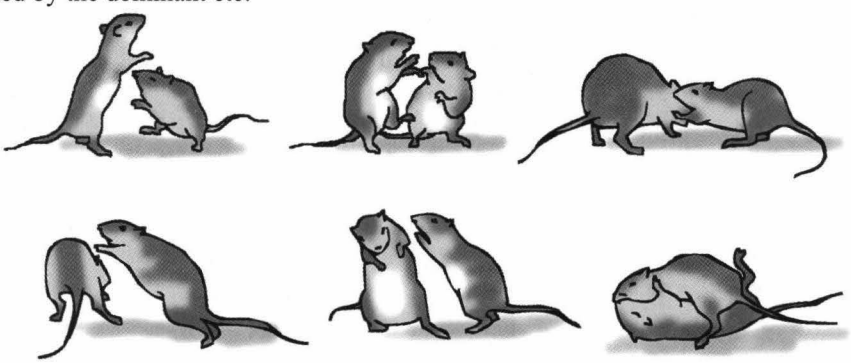


Figure 2. Various types of aggressive contacts. / Figura 2. Diverse tipuri de contacte agresive.

According to the functional importance the described elements were grouped into: meeting, aggressive, defensive, conflictual, friendly behaviour.

Meeting behaviour was expressed in the initiation of the contact, various types of olfactory contacts, exploratory behaviour.

Aggressive behaviour included attacks, fights, chase that sometimes finished with winning over the partner (it laid down on its back and the chase was over), occupation of the territory, aggressive stands. The sequence and the set of antagonistic behaviour elements were varied: attack-fight-chase-winning; attack-aggressive stand-boxing-fight; attack-fight-occupation; attack-aggressive stand-chase etc.

Defensive behaviour: running before or after attack, boxing, watching the partner in order to maintain the safe distance from it, pushing, squeak, freezing, subordination postures (lying on its back, head bowing in front of the partner).

Conflictual behaviour was expressed in ignoring the contact initiation, domination-subordination, grooming, allogrooming. The contact ignoring was expressed in that one of the animals at the initiative of contact from the other continued to commit the same acts that occurred prior to this. At the superiority of one of the partners the relations of domination-subordination were observe. In this case the subordinate animal allows to be trampled by the dominant, walking, sitting on itself, and when attempted to escape the dominant tried to keep the subordinate by force. We distinguish these elements from above mentioned subordinate postures that occur during the aggressive contacts.

Friendly behaviour is formed by the following elements: going after the partner, getting together, climbing above, under, over the partner, allogrooming.

Allogrooming was assigned, on the one hand, to conflictual behaviour, because there might have occurred relations of domination-subordination, and sometimes even aggressive grooming was observed: the dominant animal was biting while cleaning the subordinate. On the other hand, with equal partners the allogrooming is an element of friendly behaviour (Fig. 3).

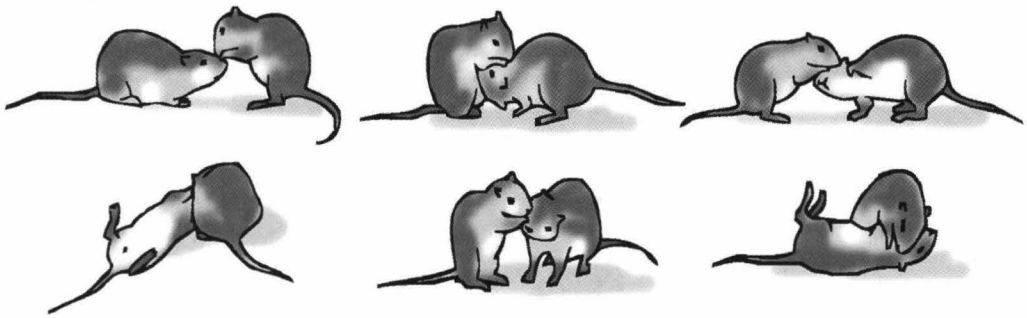


Figure 3. Various types of allogrooming. / Figura 3. Diverse tipuri de alogrooming.

The grooming was assigned to conflictual behaviour because it often represents a manifestation of shifted activity. At the same time it can be an element of comfortable behaviour.

We have to point out that not all the mentioned elements were registered in each individual; the most varied was the behaviour of *A. uralensis* males.

Among the variety of behavioural responses the elements related to agonistic interactions are the most important, because it is known the role of aggression in the mechanisms of regulation of small mammals population number (GROMOV, 2008; CHITTY, 1957; KREBS & DAVIES, 1993; MYERS & KREBS, 1971), so when characterizing the behaviour of the described species, we pay attention first of all to the degree of aggressiveness of animal contacts.

The aggressiveness of male contacts in *A. uralensis* was rather low: in average at pair interactions there were recorded 4 attacks, 9 fights, 9 aggressive stands and 1.5 chases. "Noise degree" of these interactions was low, of only 5.5 squeaks. Most of the duration of the experiment the animals explored the environment (46.7% of the time) and freeze (22.3%); for grooming they allotted little time: 4.4%. Contact initiation by one of the partners rarely caused negative reactions from the other (on 11 initiations 2.5 rejections), most often it led to mutual naso-nasal, naso-lateral and naso-ventral contacts. Allogrooming was completely absent.

The interactions of the females of this species were friendly, the aggressions was practically absent: on 9 contact initiations there were 1.5 rejections and 4 aggressive postures. "Noise effect" of these contacts constituted 4.3 squeaks, while attacks, fights and chases were absent. 81% of the time was devoted to exploratory activity (34.9% which is 1.3 times less than in males) and freezing (46.1%, which is 2 times higher than in males). Grooming constituted 3.8% of the time, 1-2 friendly allogroomings were registered at each pair encounter.

Intraspecific contacts of the males of *A. sylvaticus* were rather friendly: only in one from two encounters could be recorded one attack and one fight and not each of these aggressive elements leads to pursuit (0.92). The degree of "noise" was also low - 1.29, on each 4 encounters 5 squeaks were registered. Most of the time (48.7%) the males sited quietly in their own corner and explored the territory (28.3%), the grooming occupied 5.3% of the time. Mutual interest was manifested in contact initiations (10.58 per encounter), which sometimes led to rejection (2.0) or to aggressive posture (1.2), but more often to mutual friendly contacts and allogrooming (2.63).

In the contacts of *A. sylvaticus* females the aggression was almost completely missing, but they were more emotional. Thus, the contact initiations increased only 1.2 times, while the number of "noise" effects - 5.3 times. For every 12.5 contact initiations there were registered 2.7 rejections, 2.5 aggressive postures and 3.2 allogroomings; no attacks, fights and pursuits were recorded. Overall 79.4% of the time was used by the females for exploratory activity (33.8%) and for quiet sitting in the corner (45.6%).

Interspecific relations of the studied mice species were generally peaceful. Thus, in *A. uralensis* males the aggressiveness level in contacts with *A. sylvaticus* males decreased significantly in comparison with the intraspecific ones. There were registered one attack (instead of 4, particular for the intraspecific contacts) and 0.9 fights (instead of 9), at the same time the "noise" level increased almost 2 timed, no pursuits were recorded (instead of 1.5 in the intraspecific contacts of the species).

A. sylvaticus males were even more peaceful toward the males of other species than to the conspecifics: the low level of aggressiveness described above decreased 2 times. The interest toward the males of *A. uralensis* by comparison to the males of their own species was 2 times higher, the same index in *A. uralensis* males decrease by 1.5 times. Therefore, in intraspecific contacts the contact initiations from *A. sylvaticus* part increased by almost 3 times than form *A. uralensis* part. On every contact initiation (20 initiations of one encounter) the males of *A. uralensis* responded by rejection (3.5 rejections, which is 1.4 times higher than the intraspecific index) and aggressive posture (15.5 aggressive postures, which is 1.7 time higher than the intraspecific index).

On contact initiation from the part of *A. uralensis* the males of *A. sylvaticus* responded by friendly allogrooming (2.0 per encounter), by mutual olfactory contact or completely ignored it and continued to explore the

environment (42.1% of experiment duration, which is 1.5 times higher than the analogical index for intraspecific relations), or sited quietly in their corner (66.3%, which is 1.4 times lower, correspondingly).

In interspecific contacts of the females in opposite to the intraspecific ones, there were registered aggressive elements, but in low number. On every encounter in *A. uralensis* females there were recorded 2 attacks and 1 fight, while in *A. sylvaticus* on 10 encounters - 8 attacks and 9 fights, pursuits were not recorded.

The females of *A. sylvaticus* explored the environment (36.9% of experiment duration) and tried actively to get acquainted with the partner (number of contact initiations increased 2 times by comparing with intraspecific contacts and was 2.4 times higher than the analogical index of females of *A. uralensis*). In *A. uralensis* females it considerably increased the complex of defensive behaviour: practically on every contact initiation they responded by aggressive posture or by squeaks. The duration of freezing was 2 times longer than of exploratory activity, while the last one decreased 1.3 times. By comparison with intraspecific contacts the "noise" level increased 3.7 times and the number of aggressive postures 5.2 times.

CONCLUSIONS

Animal behaviour is complex. The identified complexes of the acquaintance, aggressive, protective (defensive), conflict, friendly, comfortable behaviour includes 22 elements, shown by wild mice in pair encounters.

Animal behaviour has species specificity. Thus, intraspecific interactions in *A. uralensis* populations are tenser than in *A. sylvaticus* populations, which is connected with the presence in males of the first species of a well pronounced complex of aggressive behaviour.

Interspecific relations in *A. uralensis* and *A. sylvaticus* communities are also specific. Generally they were peaceful. In *A. sylvaticus* male contacts the elements of aggression were practically missing, while in *A. uralensis* males the number of attacks decreased 4 times and of fights 10 times in comparison with the intraspecific indexes. In female encounters, on the contrary, elements of aggression were revealed from *A. uralensis* part as well as from *A. sylvaticus* part, which were missing in intraspecific contacts. The emotionality of *A. uralensis* females also increased.

Taking into account the importance of aggressiveness in the mechanisms of number regulation, we can presume that in the regulation of the population number the males have the leading role, while in the regulation of communities as a whole - the females.

REFERENCES

CHITTY D. 1957. *Self – regulation of numbers through changes in viability.* Cold Spring Harber Simposia of Quantitative Biology. **22**: 277-280.

COIRNS C. & SCHOLZ P. 1973. *Fighting in mice: dyadic escalation and what is earned.* Journal of Comparative & Physiological Psychology. **85**(3): 540-550.

GOLTSMAN M. E., NAUMOV N. P., NIKOLSKII A. A., OVSIANNIKOV N. G., PASKHINA N. M., SMIRIN V. M. 1977. *Sotsialnoe povedenie bolshoi peschanki (Rhombomys opimus Licht.)* in Povedenie Mlekopitayushchikh. Edit. Nauka. Moskva: 5-69. [In Russian].

GROMOV V. S. 2008. *Prostranstvenno-etologicheskaia structura populiatsii gryzunov.* Edit. Nauka. Moskva: 267-283. [In Russian].

KREBS J. R. & DAVIES N. B. 1993. *An introduction to behavioural ecology.* 3rd. edition. Blackwell Scientific Publishing Cambridge, Mass. 420 pp.

MANTEIFEL B. P. 1987. *Ecologicheskie i evolitsionnye aspecty povedenia zjivotnyh.* Edit. Nauka. Moskva. 272 pp. [In Russian].

MYERS J. H. & KREBS C. J. 1971. *Sex rations in open and enclosed vole populations: demographic implication.* American Naturalist. Ecology. **105**: 344-352.

Cemirtan Nelli, Nistreanu Victoria, Larion Alina, Savin Anatol
Institute of Zoology of ASM
Str. Academiei, No.1, Chişinău, Moldova
E-mail: vicnistreanu@gmail.com

Received: March 20, 2011
Accepted: August 22, 2011

CONTRIBUTIONS TO THE KNOWLEDGE OF PATHOLOGY OF THE SPECIES *Otaria byronia* (BLAINVILLE, 1820) - PINNIPEDIA IN CAPTIVITY CONDITIONS

CURLIŞCĂ Angelica, CAISIN Ancuţa, PAPADOPOL C. Nicolae, CRISTEA Victor

Abstract. In the last years, specialists in marine mammals, especially those dealing with pinnipeds have shown an increasing interest in the diseases of the species that belong to this order. They monitored both populations in their natural habitat, as well as those in captivity. In the present paper, after specialized scientific papers consultation, authors classify the diseases reported at the two specimens of *Otaria byronia* from the Dolphinarium pools, department of the Natural Sciences Museum Complex Constanţa.

Keywords: *Otaria byronia*, pinniped disease, captivity.

Rezumat. Contribuţii la cunoaşterea patologiei speciei *Otaria byronia* (BLAINVILLE, 1820) - Pinnipedia în condiţii de captivitate. În ultimii ani specialiştii în mamifere marine, în special cei care se ocupă de pinipede, au arătat un interes crescut în ceea ce priveşte bolile speciilor ce fac parte din acest ordin. Au urmărit atât populaţiile aflate în habitatul lor natural, cât şi pe cele aflate în captivitate. În prezenta lucrare, urmărind literatura de specialitate, autorii încadrează bolile semnalate la cele două exemplare de *Otaria byronia* aflate în bazinele secţiei Delfinariu din cadrul Complexului Muzeal de Ştiinţe ale Naturii Constanţa.

Cuvinte cheie: *Otaria byronia*, bolile pinipedelor, captivitate.

INTRODUCTION

In the specialized literature, it is specified that the diseases encountered in pinnipeds may be caused by micro-organisms (viruses, bacteria, fungi), protozoa, metazoans, neoplasia, eating disorders, eye diseases, abnormalities FLEISCHMAN & SQUIRE (1970); GREENWOOD (1985); DUNN et al., (2001); GAGE (2002); GEARHART (2006); KINNE (1985).

It is necessary to consider that captive pinnipeds face two main factors that create the premises for the occurrence of infectious and parasitic diseases, present in zoos, dolphinariums/Oceanaria. We note in particular the reduction of space in captivity, in an artificial biotope, compared with the space they hold in their natural habitat.

This relational increased density of individuals per unit area, favouring successive passage of pathogens from one host to another and causing exacerbation of virulence of the strain in question, as well as the permanent contact with the same substantially limited space, makes it difficult to maintain proper hygienic conditions of the zoo conditions, resulting a massive concentration of germs per unit area and this increases the possibility of residual proportional infection.

A second determinant is made up of strong reducing capacity of resistance of animal's aggression against many and various stressful environmental factors, new or modified compared with those of the natural habitat. An additional factor is the likely absence of an acquired immune from contact potential long bio-pathogens agents found in benign conditions of captivity.

Since 1995, the Natural Sciences Museum Complex Constanţa has two specimens of South American sea lion *Otaria byronia* (Pinnipedia: Otariidae).

Over time, these specimens confronted with various diseases, which we try to present below.

MATERIAL AND METHODS

The whole history of the pathology of the two *Otaria byronia* specimens kept in the basins of the Dolphinarium department from the Natural Sciences Museum Complex Constanţa is found in the medical records and in the custodians' works, in the period 1995-2011. In Table 1 there are included: period of observations; diagnosis, symptoms and treatment. To the information taken from these documents, there can be added the observations made by the authors in this period.

These observations were made daily, on average once a day, which means 3,650 observations for *Arctocephalus pusillus* and 5,628 observations for *Otaria byronia*.

RESULTS AND DISCUSSIONS

It is noted the predominance of diseases caused by the state of captivity, sea water quality, obvious deficiencies in nutrition and stress isolation for these highly gregarious species.

The species in question were mainly affected by:

- **Eye diseases**: eye inflammation, conjunctivitis, keratitis, diseases that have an incidence of 40% of all reported diseases. Among the eye diseases 55% of the recorded cases were eye infections, while keratitis and conjunctivitis were reported only in 20% of cases.

- **Enteritis** is another category of bacterial infections, relatively common in the dolphinarium (approx. 20%), the contributory factor consisting in lower quality food.

- **Respiratory problems** (acute bronchitis, lung congestion, microbronchitis) are also relatively frequent; the specimen *Arctocephalus pusillus* died from pneumonia, according to the necropsy report presented by the veterinarian. These problems are caused either by an inadequate microclimate, high concentrations of chlorine, or bad ventilation in indoor premises. Bronchitis was diagnosed in approx. 40% of cases, and was accompanied in 25% of them by cough with expectoration.

The other problems have had a secondary effect, but were not neglected. There were carefully observed:

- musculoskeletal disorders appearing from trauma to overwhelm joints (dislocations, sprains);
- avitaminosis caused by stress are very frequent at the end of each summer.

It is noted, given the small number of sea lions and dolphins, the good quality of the frozen fish that was also rigorously controlled, which led to the avoidance of certain diseases caused by metazoa.

In Table 1 there are presented in a summary, the main results of the undertaken investigations.

CONCLUSIONS

From the data presented in the table above it can be concluded the following:

- the most frequent diseases recorded on our investigated specimens are the eye diseases: eye inflammation, conjunctivitis, keratitis (GREENWOOD, 1985; STOSKOPF et al., 1983; GAGE, 2002). It is possible that the factor that triggers them to be the presence of sodium hypochlorite in pools water (in excess of 0.1 mg / l free chlorine) and exposure to flashes of cameras and bright light during the summer.

COLITZ et al., 2010, mentions in his book that Otariids keratitis clinically is a progressive disease with unknown etiology, which affects both juveniles and adults (Photo 3). An enclosure away from strong light and with shadow seems to slow the disease progression and prevents the occurrence of relapse as often.

Bacterial infections - Enteritis - are another category of relatively common disease in the dolphinarium - Oceanarium. The etiologic agent belongs to the genus Pasteurella BOGATU & MUNTEANU (2008). The contributory factor is poor quality food. This condition is accompanied by loss of appetite, feeding, malnutrition; respiratory diseases (acute bronchitis, lung congestion, microbrochitis) are also relatively common.

We should also mention the musculoskeletal disorders arising from trauma (dislocations, sprains).

Also, they note that at the end of each summer season the animals are physically exhausted and that for a period they receive: Polivitaminizant S, Vit E, Spirulina.

In conclusion we can say that the diseases recorded to *Otaria byronia* specimens present in the basins of Dolphinarium are common diseases for captive pinnipeds. Unlike other Oceanaria/Aquariums holding such marine mammals, in our case there were not recorded metazoans related illnesses in the investigated period.

Table 1. The main problems reported in *Otaria byronia* from the pools of the Natural Sciences Museum Complex Constanţa, period 1995-2011 - multi-data. / Tabel 1. Principalele afecţiuni semnalate la exemplarele de *Otaria byronia*, din bazinele Complexului Muzeal de Ştiinţe ale Naturii Constanţa, perioada 1995-2011- date multianuale.

Period	Diagnosis	Symptoms	Treatment
August 1995 - December 1995	Eye diseases	Inflammation of the eyelids	Eye ointment
	Erythema	Inflammation around whiskers muzzle, mucous membranes and skin	Vitamin A, Polivitamin + application of propolis ointment to the affected areas
	Loss of appetite, malnutrition	Loss of weight	Vitamin E, Vitamin B1 and polivitamins
1996 - 2011	Anorexia – infection and intoxication with gram +	Symptoms of anorexia (loss of appetite, excessive weight loss)	Ephicilin capsules 500 mg, Ampicillin capsules 100 mg Polivitamins
	Eye Infection	Ocular inflammation with eye leaking	Vitamin E capsules, Retinol
	Enteritis	Soft faeces	Anti-diarrheal capsules Neo-me-vit and a veterinary antidiarrhoeal (Bmix)
	Keratitis (Photo 4)	Inflammation of the right eye	Eye ointment, Vitamin A forte Vitamin E forte
	Chronic Keratitis	Chronic inflammation of the right eye, chronic turbidity	Instillation in the lacrimal sac of the right eye with Vitredent (vitreolent) drops
	Acute Bronchitis		Antibiotics: doxycycline-pills, Supradin, Vitamin E forte, Vitamins B1, Vitamin B6
	Left dislocation fin (male John)		
	Bronchopneumonia	Cough	Doxycycline
	Conjunctivitis	Watery secretion, purulent around the eyes	Kanamycin, vitamin B6, Neoxigal
	State of intoxication with chlorinated rubber and thinner vapours, with inflammation of the nasal airways before and nasal secretions	Cough straight (forced diaphragm apnoea), a state of apathy and prostration	Doxycycline, Polivitaminizant, Vitamin A forte, Vitamin C200, Sicovit A+D2, E Fortex, Ca lactic
	Infection of urogenital organs	Loss of appetite, chills, high temperature	Doxycycline; Erythromycin, Polivitaminizant, Sicovit, E fortex

Period	Diagnosis	Symptoms	Treatment
	Infection with *Proteus*	Loss of appetite, chills, high temperature and agitation, anorexia	Doxycycline, Erythromycin, Polivitaminizant, Sicovit, E fortex, Kanamycin 25%; Dexpirano
	Congestion of the lungs	Runny nose, spit	Doxycycline, Sicovit C, Vitamin A Forte, Vitamin E Forte, Polivitamins
	Acute bronchitis with chronic tendency	Cough, nasal discharge with scarlet red, spit	Miofilin
	Microbronchitis	Sero – sangvinolent sput	Doxycycline, Sicovit C
	Physical exhaustion	Tiredness	Polivitaminizant S, Vitamin E
	Right Fin - straight dislocation (female Lorry) + Arthritis (Photo 1, Photo 2) and possible possibly associated with a benign tumour such as a fibroma.		Ketonal, Artrostop, Gastrofit

REFERENCES

BOGATU D. & MUNTEANU GABRIELA. 2008. *Tratat de ihtiopatologie*. Excelsior Art. Timisoara. 827 pp.

COLITZ CARMEN M. H., RENNER M. S., MANIRE C. A., DOESCHER BETHANY., SCHMITT T. L., OSBORN S. D., CROFT LARA, OLDS JUNE, GEHRING ERICA, MERGL JUNE, TUTTLE ALLISON D., SUTHERLAND-SMITH MEG ., RUDNICK J. C. 2010. *Characterization of progressive keratitis in Otariids*. Veterinary Ophthalmology. **13**: 47-53.

COLITZ CARMEN M. H., SAVILLE WILLIAM J. A., RENNER MICHAEL S., MCBAIN JAMES F., REIDARSON THOMAS H., SCHMITT TODD L., NOLAN ELIZABETH C., DUGAN STEVEN J., KNIGHTLY FELICIA, RODRIGUEZ MAYA M., MEJIA-FAVA JOHANNA C., OSBORN STEVEN D., CLOUGH PATRICIA L., COLLINS SCOTT P., OSBORN BEVERLY A., TERRELL KIMBERLY. 2010. *Risk factors associated with cataracts and lens luxations in captive pinnipeds in the united states and the Bahamas*. Journal of the American Veterinary Medical Association. **237**(4): 429-36.

DUNN J . LAWRENCE. , BUCK JOHN D. , ROBECK R. TODD. 2001. *CRC Handbook of Marine Mammal Medicine Health, Disease, and Rehabilitation.* Edited by Leslie A . Dierauf and Frances M . D . Gulland CRC Press 2001: 305-339.

FLEISCHMAN ROBERT W . & SQUIRE ROBERT A. 1970. *Verminous Pneumonia in the California Sea Lion (Zalophus californianus).* Veterinary Pathology. **7**(2): 89-101.

GAGE LAURIE J. 2002. *Overview of Known and Suspected Causes of Captive Pinniped Eye Problems.* WSAVA Congres,Veterinary Information Network, Inc. (VIN) - Available from The 35th Congress of the World Small Animal Veterinary Association Proceedings Online - www.wsava.org. (accesed to march, 2011).

GEARHART S. A. 2006. *Basic clinical medicine of pinnipeds*. Proceedings of the North American Veterinary Conference - Exotics - Aquatic Medicine NAVC Orlando, Florida. **20**: 1503-1505.

GREENWOOD A. G. 1985. *Prevalence of ocular anterior segment disease in captive pinnipeds*. Aquatic Mammals Document & Publication Services at Western Illinois University. **1**: 13-15.

KINNE OTTO. 1985. *Diseases of Marine Animals - Introduction, Pisces, Reptilia, Aves, Mammalia.* Biologische Anstalt Helgoland, Hamburg, Federal Republic of Germany. **4**(2): 683-793.

STOSKOPF M. K., HIRST L. W., GRAHAM D. 1983. *Ocular anterior segment disease in captive pinnipeds*. Aquatic Mammals, Document & Publication Services at Western Illinois University. **10**(2): 34-44.

Curlişcă Angelica, Caisin Ancuţa, Papadopol Nicolae C.
Natural Sciences Museum Complex Constanţa, Bv. Mamaia
No. 255, 900552, Constanţa, Romania
E-mail: angysan2002@yahoo.com
E-mail: ancacaisin@yahoo.com

Cristea Victor
University "Dunărea de Jos" Galaţi
Faculty of Food Science and Engineering
Str. Gării, No. 61-63 body A, Galaţi, Romania
E-mail: victor.cristea@ugal.ro

Received: March 30, 2011
Accepted: August 22, 2011

Photo 1. Right Fin - straight dislocation (female Lorry).
Foto 1. Luxaţie la înotătoarea dreaptă (femela Lorry) (foto: Curlişcă Angelica).

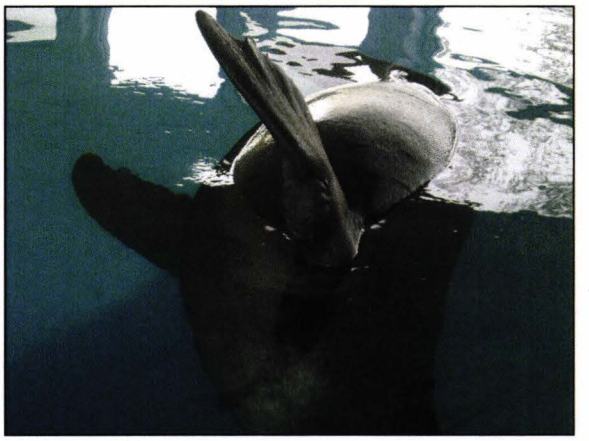


Photo 2. Right Fin - straight dislocation + Arthritis possibly associated with a benign tumour such as a fibroma. (female Lorry).
Foto 2. Luxaţie la înotătoarea dreaptă agravată de artrită şi o posibilă tumoare /fibrom (femela Lorry)
(foto: Curlişcă Angelica).

Photo 3. Stage 1 Otariid Keratitis ("Characterization of progressive keratitis in Otariids"- COLITZ et al., 2010).
Foto 3. Keratita Otariidelor - Stadiul 1 (COLITZ et al., 2010).

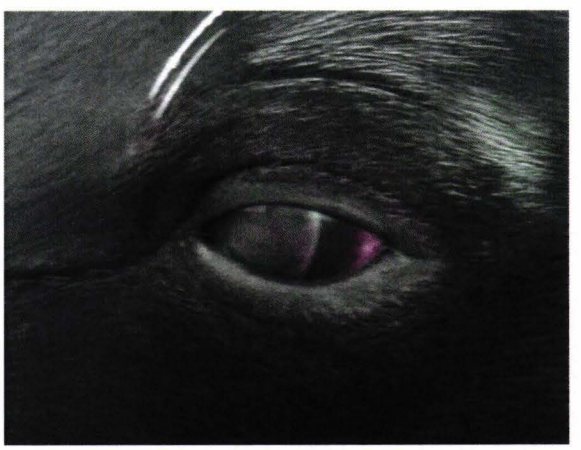


Photo 4. Stage 1 Keratitis (male John).
Foto 4. Keratita - Stadiul 1 (masculul John)
(foto: Curlişcă Angelica).

GROUNDWATER POLLUTION DUE TO INFILTRATIONS FROM ASH DEPOSITS. CASE STUDY: S. C. RENEL S. A. CRAIOVA

GAVRILESCU Elena

Abstract. Industry development and globalization have led the EU to reconsider the immediate need for production and transportation of thermoelectric power (PETRESCU-MAG & BURNY, 2008). The main objectives in this area are related to the minimization of environmental impact and to the development of a sustainable energy system (BALMACEDA et al., 2003). Irrespective of its production process, there are affected all the environmental components, namely water, aquatic habitat, air and soil (GAVRILESCU & GAVRILESCU, 2009). The study consisted of a hydro-geological mapping that has been done through a reference system of chemism of water types from the phreatic water level upstream and downstream of the location of ash dumps belonging to S.C. RENEL S.A. There have been determined the main chemical elements and established the variation thresholds in comparison to the standards in force. There have been established the characteristics of the environment where the phreatic water from the Jiu floodplain is stuck, its continuity and discontinuity as the deposit rock and the flow features in this environment. The most analysed indicators exceed the permitted limit.

Keywords: groundwater, ash and slag deposits, infiltrations, thermal power plants, water pollution.

Rezumat. Poluarea apelor subterane datorată infiltraţiilor de la depozitele de cenuşă. Studiu de caz: S. C. RENEL S. A. Craiova. Dezvoltarea industriei şi fenomenul globalizării au determinat UE să reconsidere nevoia imediată de producere şi transport al energiei termoelectrice (PETRESCU-MAG & BURNY, 2008). Principalele obiective în acest domeniu se referă la minimizarea impactului de mediu şi dezvoltarea unui sistem energetic durabil (BALMACEDA et al., 2003). Indiferent de modul de producere al acesteia sunt afectate toate componentele mediului, respectiv apa, habitatul acvatic, aerul şi solul (GAVRILESCU & GAVRILESCU, 2009). Studiul a constat într-o cartare hidrogeologică care s-a realizat printr-un sistem de referinţă a chimismului tipurilor de apă din orizontul de apă freatică în amonte şi în aval de amplasarea haldelor de cenuşă aparţinând S.C. RENEL S.A. S-au determinat principalele elemente chimice şi s-au stabilit limitele de variaţie în comparaţie cu standardele în vigoare. Au fost stabilite caracteristicile mediului în care este cantonat freaticul din Lunca Jiului, continuitatea şi discontinuitatea acestuia ca rocă magazin precum şi particularităţile curgerii prin acest mediu. S-au constatat depăşiri peste limita admisă a celor mai mulţi indicatori analizaţi.

Cuvinte cheie: ape subterane, depozite de cenuşă şi zgură, infiltraţii, centrale termoelectrice, poluarea apei.

INTRODUCTION

The phreatic water pollution from the S.C. RENEL S.A. area depends on the used fuel, production technologies and the thermal power plants location. The fuel used by the plants is the lignite extracted from the Oltenia mining basin, consisting of organic mass which contains carbon, hydrogen, nitrogen, oxygen, sulphur from the organic combinations, combustible mass and heavy metals: scandium, cobalt, strontium, yttrium, zirconium, and caesium. Some of these metals are found in the ash and slag deposited in the adjacent areas of the plant (RACOCEANU & POPESCU, 2006). As a result of the meteorological phenomena (rain, wind), they are transported in the phreatic waters through seepage and infiltration phenomenon. The ash dumps contain also radioactive elements (radium, thorium, uranium) that also pollute the aquatic environment. EU imposed in 2012 the re-engineering of thermal power plants, so by using the inertization technology, of "dense fluid discharge" type, the ash and slag are converted into an inert waste, such as construction materials as the organic ash rock (DIŢOIU & HOLBAN, 2005). Also, the existing ash dumps must be stabilized, one of the methods is to apply a thick layer of soil of 10-20 cm and cultivate it with trees species (acacia) and shrubs (sea buckthorn, hawthorn), ameliorative plants, to prevent their dissipation (DUMITRU, 2005).

MATERIAL AND METHODS

The study was conducted in 2008-2010 in the adjacent area of the S. C. RENEL S. A. thermal power plant, which is located at 11 km north-northwest from the centre of Craiova municipality, on the left bank of the Jiu river, in an industrial zone, covering an area of 440 ha, from which the slag and ash deposits cover 306 ha. They are located in the north and west part of the plant, having about 136 and respectively 170 ha, with a height of approx. 40 m. In order to determine the level of pollution of the phreatic waters in the area of slag and ash deposits, water samples have been collected from the following locations: upstream and downstream of the Amaradia catchment, upstream of the Jiu left bank and upstream of the Jiu right bank, and the water from the phreatic layer drained from the slopes.

The methods used to determine the physico-chemical properties of water are complying with the Water Law 458/2002 and GD 930/2005. The following parameters were determined: conductivity, fixed residue, calcium, sodium, bicarbonates, nitrates, chlorides, sulphates, pH, alkalinity, hardness, magnesium, potassium, iron, ammonia and phosphates, the obtained values being compared to maximum admissible concentration.

RESULTS AND DISCUSSIONS

All the types of dumps and facilities, located on a permeable land, lose water through infiltrations.

The immediate consequences of these water losses are mainly the change of levels and of groundwater quality.

The physico-chemical analysis of phreatic water is correlated to a prognosis study of flows, groundwater levels and quality which involved the following:

- the knowledge of the initial groundwater regime (levels, flows, water quality characteristics, etc.);
- the determination of factors that may change the current regime of the groundwater layer, infiltration rates, the dissolved substances driven to the groundwater, the rainfall regime in the area, the influence of natural water reservoirs (the Jiu) on groundwater flow regime - levels, flows, quality, etc.

The physico-chemical analysis emphasized that the mobility component of ash leachate in groundwater (HANSEN et al., 2002). The forecast calculations of groundwater regime in the dumps area for industrial waste disposal take less into account the variation of the groundwater level and focus more on the variation of water quality. The impact of fly ash on groundwater quality was investigated by SIMSIMANA et al., 1987, which revealed the presence of SO_2, Na.

In figure 1 there is observed that all the analysed indicators exceed the maximum permitted concentration, excepting for the chlorides and sulphates. The high values of conductivity show a high degree of water mineralization (high content of dissolved organic and inorganic salts). The fixed residue value varies depending on the characteristics of the rocks with which the water interacts, adding also the involved substances after rainfalls which lead to the washing of ash and slag layer (GAVRILESCU & GAVRILESCU, 2009). When using this type of water, we can have negative economic consequences or harmful physiological effects, such as dehydration of tissue cells and even the destruction of organisms.

The figure 2 shows the variation of calcium content which does not exceed the maximum admissible concentration, only in the water sampled from the phreatic water drained from the slopes. This value is higher also due to the application of amendments. The nitrates range between normal limits, except also the phreatic waters from the slopes, whose values are induced by water infiltration from the chemical fertilizers combine and ~~to~~ the usage of the nitrogen-based fertilizers (ammonium nitrate, urea) by the inhabitants. The high magnesium content is mainly due to the mineral substratum. In figure 3 there is observed that the sodium exceeds the threshold values. The sodium is present in almost all the waters due to the high solubility of its salts and due to its abundance in the mineral deposits. Besides the infiltrations from the slag and ash deposits, it can come also from the discharges of domestic and commercial waters. These salts are not toxic, but together with potassium may lead to the metabolism disorder of aquatic organisms. The other elements, namely the pH, alkalinity and potassium, range within normal limits, depending largely on the chemical structure of the substratum. The pH plays an important role because it determines the degree of natural endurance towards the impact with acids or sodium salts, potassium, calcium and magnesium.

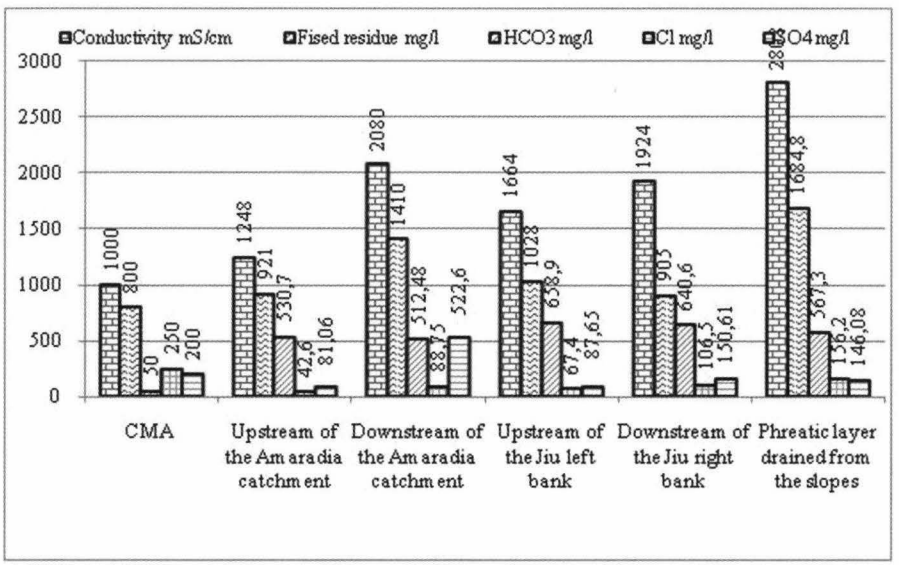


Figure 1. The values of conductivity, fixed residue, carbonates, chlorides, sulphates in the sampling points.
Figura 1. Valorile conductivității, reziduu fix, carbonați, cloruri, sulfați în punctele de prelevare.

The content of iron, ammonia and phosphates exceeds the maximum permitted values. The iron is found in the water both as ferrous, ferric or colloidal elements, being linked to the presence of humic acids. Water pH influences the form of iron. It may come from the rain water drainage which washes the ash and slag, causing a decreasing of the dissolved oxygen in the water. The ammonium ion derives from the infiltration waters from the Isalnita platform, but also from the usage of chemical fertilizers, not deriving from the ash and slag dumps. The phosphates can derive from agricultural soils drainage, meteoritic waters, industrial water discharges, being found both as organic and inorganic compounds. If the ratio of nitrogen and phosphorus changes in favour of nitrogen, the organic pollution phenomena or abnormal geochemical phenomena appear (Fig. 4).

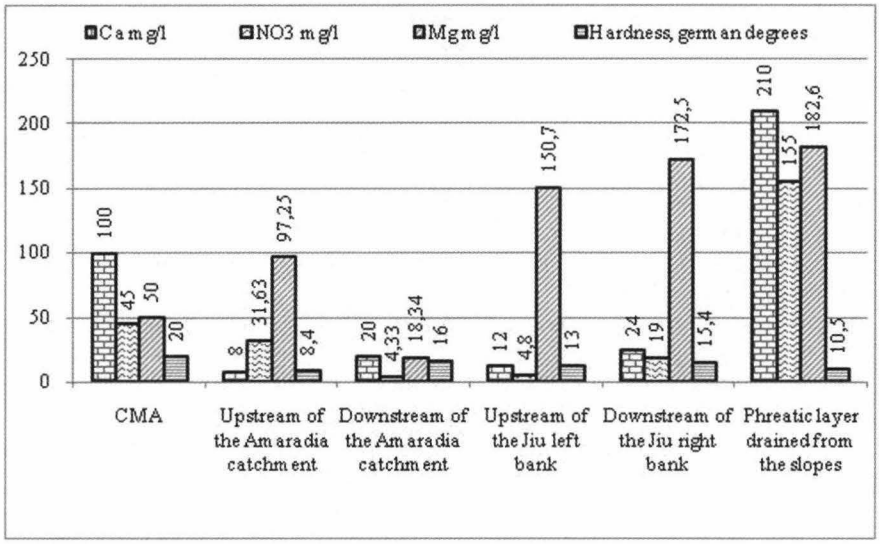


Figure 2. The values of calcium, nitrates, magnesium and hardness in the sampling points.
Figura 2. Valorile calciului, azotaţilor, magneziului şi durităţii în punctele de prelevare.

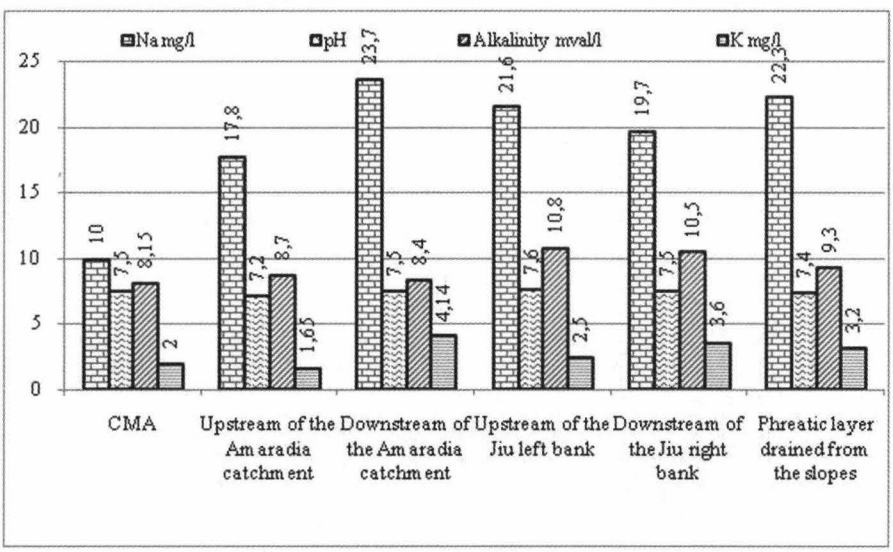


Figura 3. The values of sodium, pH, alkalinity, potassium in the sampling points.
Figura 3. Valorile sodiului, pH-ului, alcalinităţii, potasiului în punctele de prelevare.

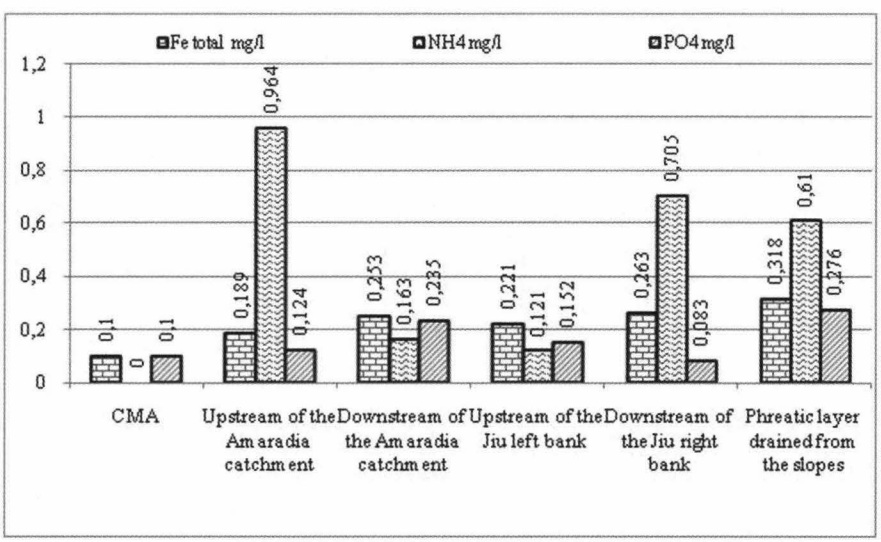


Figure 4. The values of iron, ammonium and phosphates in the sampling points.
Figura 4. Valorile fierului, amoniului si fosfaţilor în punctele de prelevare.

CONCLUSIONS

According to the carried out tests, most of the studied indicators have exceeded the maximum permitted concentrations.

In order to prevent the limitation and to eliminate the impact generated by the electricity and heat production activities based on fossil fuels (coal, oil, natural gas) there are necessary the following measures:

- supply and use of fuels, combustibles and lubricants with low content of pollutants (S, N, P, heavy metals, etc.);
- optimizing the existing production processes;
- modernization and re-engineering of facilities and equipments for neutralization, containment, dilution and dispersion of pollutants in the environment;
- adopting the best available techniques without involving excessive costs in developing projects and development programs (CIUBOTARU & SOCOLESCU, 2009);
- monitoring the quality parameters of all the environmental factors both on industrial site and in its immediate vicinity;
- development of security plans, notifying reports and internal emergency plans on the industrial site in compliance with legal regulations in force and offering the financial resources necessary for the implementation of these projects, plans and programs;
- compliance with the measures and conditions imposed by the competent bodies on the occasion of inspections made on the industrial site, and compliance with the provisions from the plans of prevention and limitation of accidental pollution, or of the action in case of disaster, or great natural phenomena (earthquakes, floods, heavy rainfalls, strong winds, drought, etc.) (BANU & RADIVICI, 2008).

REFERENCES

BALMACEDA MARGARITA M. 2002. *EU Energy Policy and Future European Energy Markets: Consequences for the Central and East European States* (online). Available from World Wide Web: http://www.mzes.uni-mannheim.de/publications/wp/wp-42.pdf (accesed to March 03, 2011).

BANU ALEXANDRA & RADIVICI O. 2008. *Elemente de ingineria şi protecţia mediului.* Edit. Tehnică. Bucureşti: 152-159.

CIOBOTARU VIRGINIA & SOCOLESCU ANA MARIA. 2009. *Poluarea si protecţia mediului.* Edit. Economică. Bucureşti: 251-270.

DIŢOIU VALERIA & HOLBAN NINA. 2005. *Modificări antropice ale mediului.* Edit. Matrix. Bucureşti: 133-135.

DUMITRU M. 2005. *Reconstrucţie ecologică. Elemente tehnologice, metode şi practici de recultivare şi depoluare.* Edit. Eurobit. Timişoara: 207-209.

GAVRILESCU ELENA & GAVRILESCU B. F. 2009. *Caracterul şi provenienţa apelor uzate industriale şi influenţa lor asupra emisarului.* Edit. Sitech. Craiova: 210-228.

HANSEN YVONNNE, NOTTEN PHILIPPA J., PETRIE JAMES G. 2002. *The environmental impact of ash management in coal-based power generation.* Applied Geochemistry, Elsevier Science. Sydney. **17**: 1131-1141.

PETRESCU-MAG RUXANDA MĂLINA & BURNY PH. 2008. *Environmental policies and legislation.* Edit. Bioflux. Cluj-Napoca: 95-106.

RACOCEANU C. & POPESCU C. 2006. *Evaluarea emisiilor poluante rezultate prin arderea lignitului în CET de mare putere.* Edit. Sitech. Craiova: 11-15.

SIMSIMANA GERONIMO V., GHESTERS G., ANDREN ANDERS W. 1987. *Effect of ash disposal ponds on groundwater quality at a coal-fired power plant.* Water Research. Georgia. **21**: 417-426.

Gavrilescu Elena
University of Craiova, Faculty of Horticulture
A. I. Cuza Str. No. 13, 200585, Craiova, Romania
E-mail: gavrilescu_elena@yahoo.com

Received: March 20, 2011
Accepted: August 20, 2011

STRUCTURE AND DYNAMICS OF THE PHYTOPLANKTON FROM VÂLSAN LAKE

VLĂDUŢU Alina - Mihaela

Abstract. In the year 1967, the Vâlsan river had suffered important modifications by constructing upstream of Vâlsan Gorges and the confluence with its tributary, the Dobroneagu river, a reservoir whose water is led in Vidraru Lake, and also a hydroelectric–plant with an installed power of 5 MW. Vâlsan Lake affects a basinal surface of 83.3 km^3; the tributary Dobroneagu is also directed towards the reservoir, which has led to the reduction of the downstream flow rate, from the values beyond 2 m^3/s until 1967 to values smaller than 0.6m^3/s presently. The dam is built in arch shape, 24 m high, the lake having a surface of 3.5 ha, gathering a 174.000 m^3quantity of water. This paper presents the structure of the phytoplankton populations in Vâlsan Lake, from both qualitative and quantitative points of view. It should be mentioned that the study of Vâlsan Lake has not been done so far, there is virtually no literature data to track and compare the qualitative and quantitative composition and evolution of plankton populations in the ecosystem since the dam construction until now.

Keywords: Vâlsan Lake, phytoplankton, diversity.

Rezumat. Structura şi dinamica fitoplanctonului Lacului Vâlsan. În anul 1967, Râul Vâlsan a suferit modificări importante prin construirea în amonte de Cheile Vâlsanului şi de confluenţa cu afluentul Dobroneagu, a unui lac de acumulare ale cărui ape sunt transportate în Vidraru şi a unei hidrocentrale cu o putere instalată de 5 MW. Acumularea Vâlsan a afectat o suprafaţă bazinală de 83.3 km^3, aici fiind drenate şi apele afluentului Dobroneagu, ceea ce a dus la o scădere dramatică a debitului râului în aval de amenajarea hidrotehnică, de la valori de 2 m^3/s până în 1967, la valori mai mici de 0,6 m^3/s în present. Barajul este construit în arc, având o înălţime de 24 m, lacul având o suprafaţă de 3,5 ha, acumulând un volum de 174.000 m^3 de apă. Lucrarea de faţă prezintă structura populaţiei fitoplanctonice a lacului Vâlsan, atât din punct de vedere calitativ, cât şi cantitativ. Trebuie notat faptul că nu a mai fost făcut nici un alt studiu asupra lacului Vâlsan, practic nu există date bibliografice pentru a urmări şi compara structura şi evoluţia calitativă şi cantitativă a populaţiilor planctonice din acest ecosistem din momentul construirii barajului şi până în prezent.

Cuvinte cheie: Lacul Vâlsan, fitoplancton, diversitate.

INTRODUCTION

The Vâlsan river (surface - 358 km^2, length - 84.6 km) springs from the Făgăraş mountains (2,310 m), flows parallel with the Argeş river, crossing the same relief group up to the river mouth, at Merişani, situated approximately half the distance between Curtea de Argeş and Piteşti (UJVÁRI, 1972).

The special interest of the Vâlsan River is the presence of the fish species *Romanichthys valsanicola* DUMITRESCU, BĂNĂRESCU & STOICA, 1957 (sculpin-perch or Romanian darter), an endemic species to Romania and the Danube basin. It is considered the most endangered species of the European ichtyofauna because of its narrow range (only a sector of the Vâlsan) and small number of individuals.

In the year 1967, the Vâlsan river had suffered important modifications by constructing upstream of Vâlsan Gorges a storage lake and also a hydroelectric–plant. This reservoir has a basinal surface of 83.3 km^3; the tributary Dobroneagu is also directed towards the reservoir, which has led to the reduction of the downstream flow rate, from the values beyond 2 m^3/s until 1967 to values smaller than 0.6 m^3/s presently.

MATERIAL AND METHODS

The investigations were made in three sampling points - tail of the lake, middle lake and dam - taking into account the heterogeneous distribution of plankton in a water body as a reservoir (HÖTZEL & CROOME, 1999, after WETZEL, 1975), during August 2007 - April 2008, thus studying the dynamics of its seasonal variation. In the middle section of the lake, we took samples from four horizons - surface and depths of 1 m, 2 m and 3 m.

The samples were taken using a Patalas-Schindler device and preserved with glacial acetic acid: Lugol solution in proportion of 1 : 100 (HÖTZEL & CROOME, 1999, after SCHWOERBEL, 1970). Microscopic analysis was done using OPTIKA B-352 Ahal microscope, with 10, 20, 40 lenses and 10 and 15 oculars. To determine the species, we used the Romanian (FRANCISC & BARNA, 1998; IONESCU & PÉTERFI, 1979, 1981) and European tools (HINDÁK et al., 1975; HORTOBAGYI, 1973) representative for the study field and the saprobity index (MĂLĂCEA, 1969; VLĂDUŢU, 2005).

RESULTS AND DISCUSSIONS

After processing the samples, there were identified 55 species belonging to Cyanobacteria (4 species), Bacillariophyta (31 species), Chlorophyta (17 species), Cryptophyta (1 species) and Dinophyta (2 species) (Table 1).

In the samples from the tail of the lake there were identified 37 species (Table 2) belonging to Bacillariophyta (21), Chlorophyta (14) and Dinophyta (2).

Table 1. Taxonomic composition of the phytoplankton in Vâlsan Lake and saprobic value of taxa.
Tabel 1. Compoziția taxonomică a fitoplanctonului din Lacul Vâlsan și valoarea saprobică a taxonilor.

No.	TAXA	SAPROBIC VALUE
	Phyllum Cyanobacteria	
1.	*Anabaena solitaria* BRUNNTHALER, 1903	o β
2.	*Anabaena spiroides* KLEBAHN, 1895	o β
3.	*Cylindrospermum stagnale* (KÜTZING) BORNET & FLAHAULT, 1888	β
4.	*Merismopedia glauca* (EHRENBERG) KÜTZING, 1845	β
	Phyllum Bacillariophyta	
5.	*Diatoma hiemale* (LYNGBYE) HEIBERG, 1863	o
6.	*Diatoma vulgare* BORY DE SAINT-VINCENT, 1824	βα
7.	*Centronella* sp. MAX VOIGT, 1902	β
8.	*Asterionella formosa* HASSALL, 1850	o β
9.	*Asterionella gracillima* HEIBERG, 1863	o
10.	*Synedra acus* KÜTZING, 1844	β
11.	*Synedra actinastroides* LEMMERMANN. 1898	o
12.	*Synedra ulna* (NITZSCH) EHRENBERG, 1832	β
13.	*Diatomella baljouriana* GREVILLE, 1855	β
14.	*Pinnularia viridis* ((NITZSCH) EHRENBERG, 1843	β
15.	*Pinnularia giba* EHRENBERG, 1843	o
16.	*Pinnularia subcapitata* GREGORY, 1856	o
17.	*Navicula cincta* (EHRENBERG) RALFS, 1861	β
18.	*Navicula bacillum* var. *gregoryana* GRUNOW, 1880	αβ
19.	*Navicula radiosa* KÜTZING, 1844	αβ
20.	*Navicula subtilissima* CLEVE, 1891	β
21.	*Cymbella augur* KÜTZING, 1844	o
22.	*Cymbella lanceolata* KIRCHNER, 1878	β
23.	*Cymbella prostrata* (BERKELEY) CLEVE, 1894	β
24.	*Cymbella ventricosa* AGARDH, 1830	o β
25.	*Gyrosigma acuminatum* (KÜTZING) RABENHORST, 1853	o β
26.	*Gyrosigma distortum* (SMITH) CLEVE, 1894	β
27.	*Gyrosigma spenceri* var. *nodiferum* (GRUNOW) REIMER, 1966	β
28.	*Gomphonema olivaceum* (HORNEMANN) BRÉBISSON, 1838	β
29.	*Diploneis ovalis* (HILSE) CLEVE, 1891	β
30.	*Amphora ovalis* KÜTZING, 1844	β
31.	*Bacillaria paradoxa* EHRENBERG, 1828	β
32.	*Nitzschia acicularis* (KÜTZING) SMITH, 1853	β
33.	*Nitzschia holsatica* HUSTEDT, 1930	α
34.	*Nitzschia subtilis* GRUNOW, 1880	α
35.	*Surirella ovalis* BRÉBISSON, 1838	β
36.	*Ankistrodesmus* sp. CORDA, 1838	β
	Phyllum Chlorophyta	
37.	*Chlorella* sp. BEIJERINCK, 1890	p-α
38.	*Pediastrum* sp. MEYEN, 1829	β
39.	*Pediastrum angulosum* EHRENBERG, 1840	β
40.	*Pediastrum duplex* MEYEN, 1829	β
41.	*Pediastrum simplex* MEYEN, 1829	β
42.	*Pediastrum tetras* (EHRENBERG) RALFS, 1844	β
43.	*Scenedesmus acuminatus* SMITH, 1916	β
44.	*Scenedesmus acutus* HORTOBÁGYI, 1954	β
45.	*Scenedesmus quadricauda* SMITH, 1916	β
46.	*Actinastrum aciculare* PLAYFAIR, 1917	β
47.	*Actinastrum hantzschii* LAGERHEIM, 1882	β
48.	*Closterium moniliferum* EHRENBERG, 1848	β
49.	*Cosmarium botrytis* MENEGHINI, 1848	o
50.	*Desmidium cilindricum* GREVILLE, 1861	o
51.	*Staurastrum* sp. MEYEN, 1848	o
52.	*Zygnema* sp. AGARDH, 1817	o
	Phyllum Cryptophyta	
53.	*Chilomonas* sp. EHRENBERG, 1831	α
	Phyllum Dinophyta	
54.	*Peridinium* sp. EHRENBERG, 1832	o
55.	*Ceratium hirudinella* var. *furcoides* (MÜLLER) DUJARDIN, 1841	β

Legend: (o = oligosaprobity; β = beta-mezosaprobity; α = alfa-mezosaprobity; p = polysaprobity).
Legendă: (o = oligosaprob; β = beta-mezosaprob; α = alfa-mezosaprob; p = polysaprob).

Table 2. Taxonomic composition and seasonal variation of the phytoplankton in the tail of the lake and dam sections.
Tabel 2. Compoziţia taxonomică şi variaţia sezonieră a fitoplanctonului din secţiunile coada lacului şi baraj.

DAM SECTION					TAIL OF THE LAKE SECTION				
No.	**TAXA**	**SU**	**A**	**SP**	**No.**	**TAXA**	**SU**	**A**	**SP**
1.	*Anabaena solitaria*	+	+	-	1.	*Diatoma hiemale*	-	+	+
2.	*Anabaena spiroides*	+	+	-	2.	*Centronella* sp.	-	-	+
3.	*Cylindrospermum stagnale*	+	+	-	3.	*Asterionella formosa*	+	+	+
4.	*Merismopedia glauca*	-	+	-	4.	*Asterionella gracillima*	+	+	+
5.	*Diatoma hiemale*	-	+	+	5.	*Synedra actinastroides*	-	+	+
6.	*Diatoma vulgare*	-	+	+	6.	*Synedra ulna*	-	+	+
7.	*Centronella* sp.	-	+	+	7.	*Pinnularia viridis*	-	-	+
8.	*Asterionella formosa*	+	+	+	8.	*Pinnularia giba*	-	-	+
9.	*Asterionella gracillima*	+	+	+	9.	*Pinnularia subcapitata*	-	-	+
10.	*Synedra acus*	-	+	+	10.	*Navicula cincta*	-	+	+
11.	*Synedra ulna*	-	+	+	11.	*Navicula bacillum* var. *gregoryana*	-	+	-
12.	*Diatomella baljouriana*	+	+	+	12.	*Navicula radiosa*	-	+	+
13.	*Pinnularia viridis*	-	-	+	13.	*Navicula subtilisima*	+	+	+
14.	*Pinnularia giba*	-	-	+	14.	*Cymbella augur*	+	+	+
15.	*Pinnularia subcapitata*	-	-	+	15.	*Cymbella lanceolata*	-	+	+
16.	*Navicula cincta*	-	+	+	16.	*Cymbella prostrata*	-	-	+
17.	*Navicula bacillum* var. *gregoryana*	-	+	+	17.	*Cymbella ventricosa*	-	+	-
18.	*Navicula radiosa*	-	+	+	18.	*Gyrosigma acuminatum*	-	+	+
19.	*Navicula subtilisima*	+	+	+	19.	*Amphora ovalis*	-	+	+
20.	*Cymbella lanceolata*	+	+	+	20.	*Bacillaria paradoxa*	-	-	+
21.	*Cymbella prostrata*	+	-	+	21.	*Surirella ovata*	-	-	+
22.	*Cymbella ventricosa*	-	+	-	22.	*Chlorella* sp.	+	-	-
23.	*Gyrosigma acuminatum*	-	+	+	23.	*Pediastrum* sp.	+	+	-
24.	*Gyrosigma spenceri* var. *nodiferum*	-	+	+	24.	*Pediastrum angulosum*	+	+	-
25.	*Amphora ovalis*	-	+	-	25.	*Pediastrum duplex*	+	+	-
26.	*Bacillaria paradoxa*	-	-	+	26.	*Pediastrum simplex*	+	+	-
27.	*Nitzschia acicularis*	-	-	-	27.	*Scenedesmus acuminatus*	+	+	+
28.	*Nitzschia holsatica*	+	+	+	28.	*Scenedesmus acutus*	+	-	-
29.	*Nitzschia subtilis*	-	-	-	29.	*Scenedesmus quadricauda*	+	-	+
30.	*Surirella ovata*	-	-	+	30.	*Actinastrum aciculare*	+	+	-
31.	*Chlorella* sp.	+	+	+	31.	*Actinastrum hantzschii*	+	-	-
32.	*Pediastrum angulosum*	+	-	-	32.	*Closterium moniliferum*	+	+	+
33.	*Pediastrum duplex*	+	+	-	33.	*Cosmarium botrytis*	+	+	-
34.	*Pediastrum simplex*	+	+	-	34.	*Desmidium cilindricum*	+	-	-
35.	*Pediastrum tetras*	+	-	-	35.	*Staurastrum* sp.	+	+	-
36.	*Scenedesmus acuminatus*	+	+	-	36.	*Peridinium* sp.	+	-	-
37.	*Scenedesmus acutus*	+	-	-	37.	*Ceratium hirudinella* var. *furcoides*	+	-	-
38.	*Scenedesmus quadricauda*	+	+	-					
39.	*Actinastrum aciculare*	+	-	-					
40.	*Actinastrum hantzschii*	+	-	-					
41.	*Closterium moniliferum*	-	-	+					
42.	*Desmidium cilindricum*	+	-	-					
43.	*Staurastrum* sp.	-	+	-					
44.	*Chilomonas* sp.	+	+	+					
45.	*Peridinium* sp.	+	-	-					
46.	*Ceratium hirudinella* var. *furcoides*	+	-	-					

Legend: (SU – summer, A – autumn, SP - spring).
Legendă: (SU – vară, A – toamnă, SP - primăvară).

Seasonal variation in the total number of species in this section is small, the most numerous being identified in autumn (22) and the fewest in summer (20).

Qualitatively, the phytoplankton is dominated by Chlorophyta in summer (14 species), while Bacillariophyta prevails in spring (19 species) and autumn (14), as shown in figure 1.

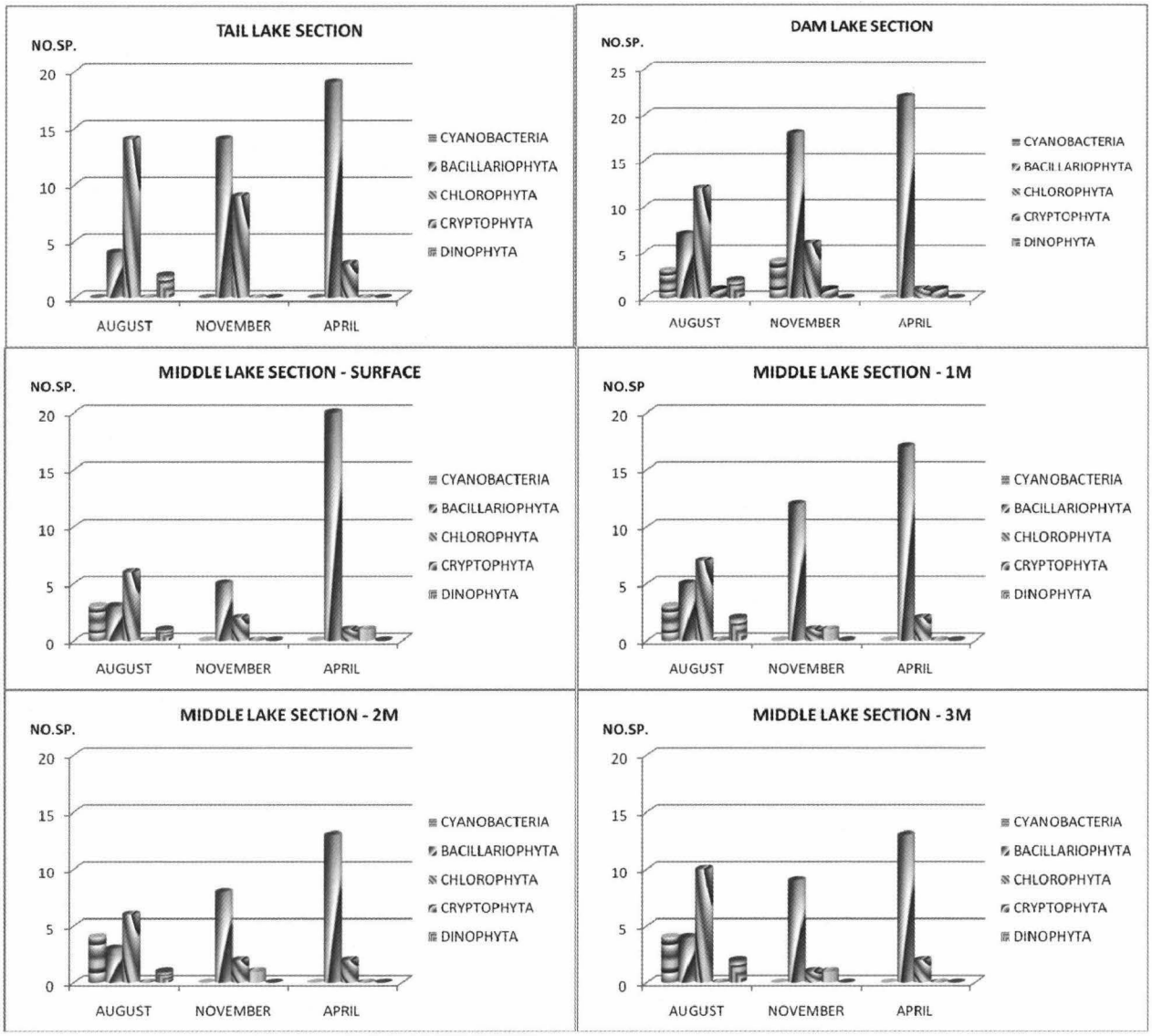


Figure 1. Number of species distribution and its seasonal variation in Vâlsan Lake.
Figura 1. Distribuția numărului de specii şi variația sezonieră a acestuia în Lacul Vâlsan.

In the samples taken from the middle section of the lake there have been identified all the 55 species belonging to Cyanobacteria, Bacillariophyta, Chlorophyta, Cryptophyta and Dinophyta (Table 3).

As the total number of species identified in all seasons (Fig. 1), diatoms are clearly the most numerous, the maximum being recorded in surface samples (21 species) and the minimum in samples from 2 m depth (13 species).

For Chlorophyta, the maximum number of species was identified in samples from the depths of 1 m and 3 m (about 10 species), the number being equal to other horizons, 6 species.

As a seasonal distribution, the green algae have the greatest number of species in summer, especially in the horizon of 3 m, which is explained by their tendency to defend against destruction of chloroplasts by exposure to strong sunlight, and in other seasons, specific diversity is very low, between 1 and 2 species per sampling.

In autumn and spring, the spectrum of the species is dominated by the algae from Bacillariophyta types, with a significant increase in the samples from April, when 20 species were identified on the water surface, but the number is t high also in the horizons 1-3 m.

Blue algae and the dinophyta have been identified only in summer samples.

The only genera of Cryptophyta identified, *Chilomonas* is absent in samples from August, being present in November in the horizons 1-3 m, and in spring, only in surface water samples.

In the dam section, the number of identified species (Table 2) is 46, of which more than half are diatoms (26).

Table 3. Taxonomic composition and seasonal variation of the phytoplankton in the middle lake section.
Tabel 3. Compoziţia taxonomică şi variaţia sezonieră a fitoplanctonului din secţiunea mijloc lac.

No.	TAXA	SURFACE			1M			2M			3M		
		SU	A	SP	SU	A	SP	SU	A	SP	SU	A	SP
1.	*Anabaena solitaria*	+	-	-	+	-	-	+	-	-	+	-	-
2.	*Anabaena spiroides*	+	-	-	+	-	-	+	-	-	+	-	-
3.	*Cylindrospermum stagnale*	+	-	-	+	-	-	+	-	-	+	-	-
4.	*Merismopedia glauca*	-	-	-	-	-	-	+	-	-	+	-	-
5.	*Diatoma hiemale*	-	-	+	-	+	+	-	-	-	-	-	+
6.	*Diatoma vulgare*	-	-	+	-	+	+	-	-	-	-	-	+
7.	*Centronella* sp.	-	-	-	-	-	+	-	-	-	-	-	-
8.	*Asterionella formosa*	-	-	-	+	-	+	+	-	+	+	-	+
9.	*Asterionella gracillima*	-	-	+	+	+	+	-	-	-	-	-	-
10.	*Synedra acus*	-	-	-	-	-	-	-	-	+	-	-	-
11.	*Synedra actinastroides*	-	-	-	-	-	-	-	-	+	-	-	-
12.	*Synedra ulna*	-	-	+	-	+	+	-	+	+	-	+	+
13.	*Diatomella baljouriana*	+	-	+	+	-	-	+	+	+	+	+	-
14.	*Pinnularia viridis*	-	-	+	-	-	+	-	-	-	-	-	-
15.	*Pinnularia giba*	-	-	+	-	-	+	-	-	-	-	-	-
16.	*Pinnularia subcapitata*	-	-	+	-	-	+	-	-	-	-	-	-
17.	*Navicula cincta*	-	+	+	-	+	+	-	+	+	-	+	+
18.	*Navicula bacillum* var. *gregoryana*	-	-	+	-	+	-	-	-	+	-	-	+
19.	*Navicula radiosa*	-	-	+	-	+	+	-	-	-	-	+	+
20.	*Navicula subtilisima*	-	-	+	+	+	+	-	+	+	-	+	+
21.	*Cymbella augur*	-	-	+	-	-	-	-	+	-	-	-	-
22.	*Cymbella lanceolata*	-	-	+	-	+	+	-	-	+	-	-	+
23.	*Cymbella prostrata*	-	+	-	-	-	+	-	-	+	-	-	-
24.	*Cymbella ventricosa*	-	-	+	-	+	-	-	+	-	-	+	+
25.	*Gyrosigma acuminatum*	-	+	+	-	+	+	-	+	+	-	+	+
26.	*Gyrosigma distortum*	-	+	+	-	-	-	-	-	-	-	-	-
27.	*Gyrosigma spenceri* var. *nodiferum*	-	-	+	-	-	-	-	-	-	-	-	-
28.	*Gomphonema olivaceum*	+	-	-	-	-	-	-	-	-	-	-	-
29.	*Diploneis ovalis*	-	-	-	-	-	-	-	-	-	-	+	-
30.	*Amphora ovalis*	-	-	-	-	+	-	-	+	-	-	+	-
31.	*Bacillaria paradoxa*	-	-	-	-	-	+	-	-	-	-	-	-
32.	*Nitzschia acicularis*	-	+	+	-	-	-	-	-	-	+	-	+
33.	*Nitzschia holsatica*	+	-	-	+	-	-	+	-	-	+	-	-
34.	*Nitzschia subtilis*	-	-	+	-	-	-	-	-	+	-	-	-
35.	*Surirella ovata*	-	-	-	-	-	+	-	-	+	-	-	+
36.	*Ankistrodesmus* sp.	-	+	-	-	-	-	-	-	+	-	-	-
37.	*Chlorella* sp.	+	-	-	-	-	+	-	-	-	-	-	-
38.	*Pediastrum* sp.	-	-	-	-	-	-	+	-	-	-	-	-
39.	*Pediastrum angulosum*	-	-	-	+	-	-	-	-	-	-	-	-
40.	*Pediastrum duplex*	-	-	-	+	-	-	-	-	-	+	-	-
41.	*Pediastrum simplex*	+	-	-	+	-	-	+	-	-	+	-	-
42.	*Pediastrum tetras*	-	-	-	-	-	-	-	-	-	+	-	-
43.	*Scenedesmus acuminatus*	+	-	-	-	-	-	-	-	-	+	-	-
44.	*Scenedesmus acutus*	-	-	-	+	-	-	+	-	-	+	-	-
45.	*Scenedesmus quadricauda*	-	-	-	-	-	-	-	-	-	+	-	-
46.	*Actinastrum aciculare*	+	-	-	+	-	-	+	-	-	+	-	-
47.	*Actinastrum hantzschii*	+	-	-	+	-	-	+	-	-	+	-	-
48.	*Closterium moniliferum*	-	-	-	-	-	+	-	-	+	-	-	+
49.	*Cosmarium botrytis*	-	-	-	-	-	-	-	-	-	-	-	-
50.	*Desmidium cilindricum*	+	+	+	+	-	-	+	+	-	+	+	+
51.	*Staurastrum* sp.	-	-	-	-	+	-	-	+	-	+	-	-
52.	*Zygnema* sp.	-	-	-	-	-	-	-	-	-	-	-	-
53.	*Chilomonas* sp.	-	-	+	-	+	-	-	+	-	-	+	-
54.	*Peridinium* sp.	-	-	-	+	-	-	-	-	-	+	-	-
55.	*Ceratium hirudinella* var. *furcoides*	+	-	-	+	-	-	+	-	-	+	-	-

Legend: (SU – summer, A – autumn, SP - spring) / **Legendă**: (SU – vară, A – toamnă, SP - primăvară).

Cyanobacteria are absent in spring, but all four species - *Anabaena solitaria, A. spiroides, Cylindrospermum stagnale* and *Merismopedia glauca* - are present in summer samples. Dinophyta are present only in samples taken in August, both genera being identified, *Peridinium* and *Ceratium*.

Seasonal variation in the number of species in each group did not differ significantly from other sections reference, with clear dominance of green algae, and in autumn and especially in spring diatoms are almost exclusively.

Quantitatively, the numerical density of phytoplankton in the tail section of the lake (Fig. 2) falls between 894 and 1,028 thousands ind./l, with an average of 971 thousands ind./l. Diatoms represented 74% of the algae of this section and in spring and autumn they are almost exclusive species (99%, respectively 94%).

In summer, the highest density is recorded in green algae (583 thousands ind./l), with a rate of 57%. Dinophyta, during this period, is represented by only two taxa – *Peridinium* sp. and *Ceratium hirundinella* var. *furcoides*, but is has a high numerical density (120 thousands ind./l), representing 12% of the total density (Fig. 3).

The quantitative analysis of the phytoplankton samples in the middle section of the lake shows that the maximum number density is recorded for diatoms in spring samples (1,116 thousands ind./l) at a depth of 1m; then, it decreases to 532 thousands ind./l at 2 meter depth and increases again to 859 thousands ind./l at 3 m (Fig. 2).

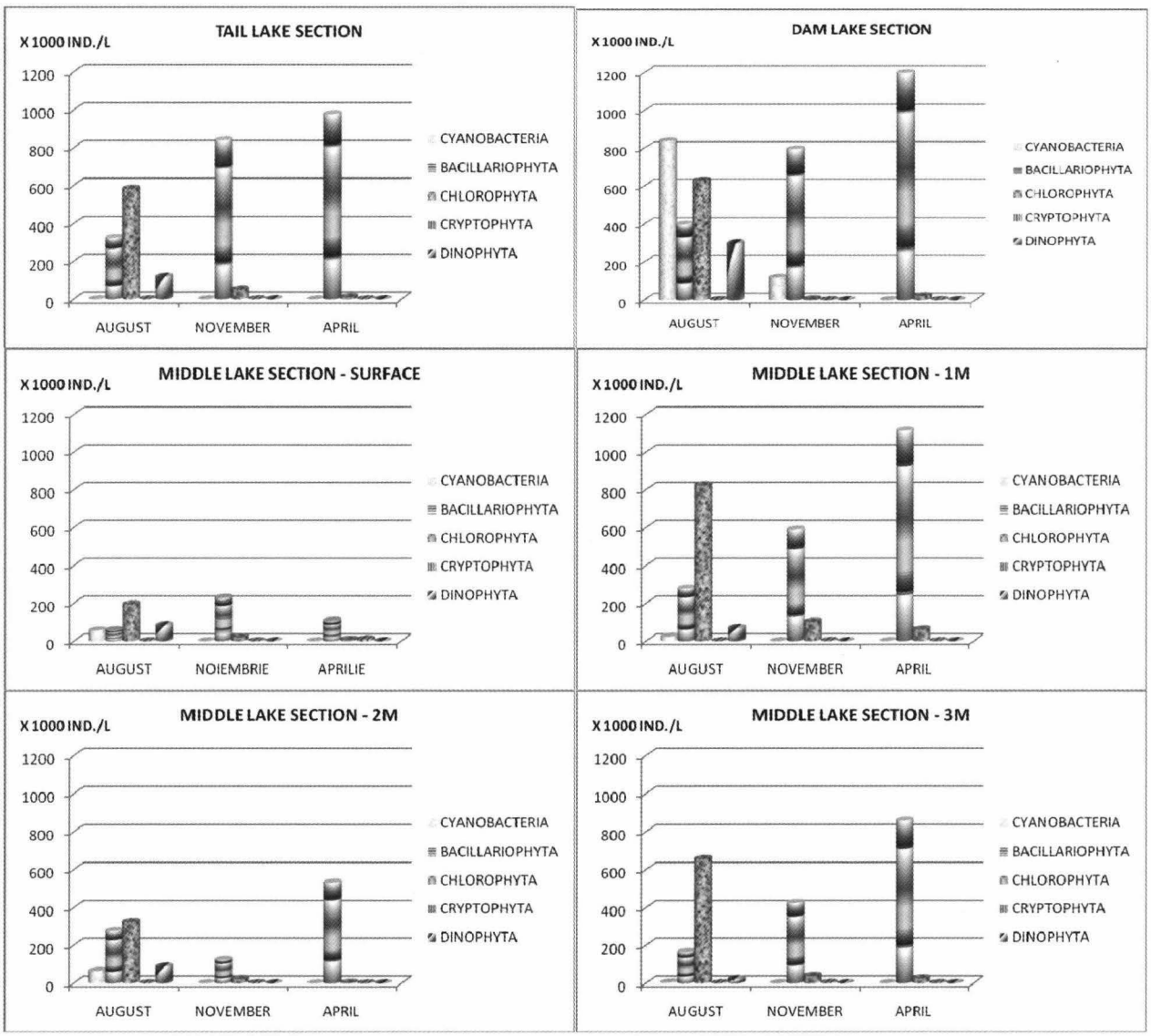


Figure 2. Numerical density and its seasonal variation in Vâlsan Lake.
Figura 2. Densitatea numerică şi variaţia sezonieră a acesteia în Lacul Vâlsan.

Green algae have the maximum number density in the 1 m samples from August (824 thousand ind. / l), and the minimum value is recorded throughout the summer in the samples from the surface of the water (195 thousand ind. / l).

The proportion of each group (Fig. 3) on the surface is relatively balanced in phytoplankton, being present all five groups, but diatoms clearly registered the largest proportion (51% - 66%).

Just as in other sampling sections, for de dam section, the structure of the phytoplankton in summer is the most balanced, with representatives from all groups in comparable proportions (Figs. 2; 3).

It is worth mentioning that Dinophyta, although it is represented only by a single species, *Ceratium hirudinella* var. *furcoides,* has a very high density, over 200 thousand ind. / l.

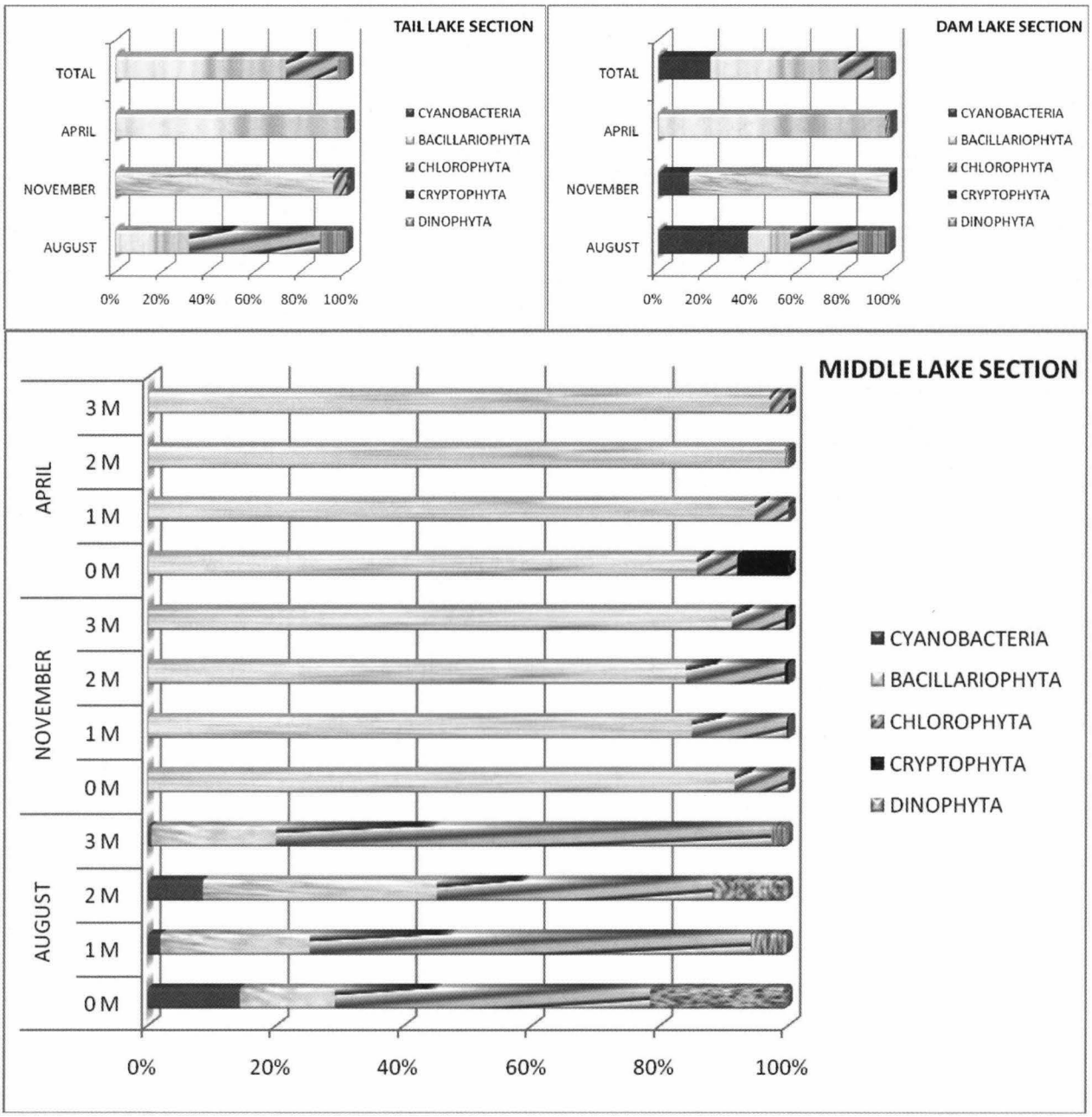


Figure 3. Phytoplankton composition and its seasonal variation in Vâlsan Lake.
Figura 3. Compoziţia fitoplanctonului şi variaţia sezonieră a acesteia în Lacul Vâlsan.

In terms of ecological quality status, analysing the corresponding saprobity index for each species (Table 1) determined from Vâlsan lake, it results that it is a mezosaprobic lake (the medium contaminated zone) and, especially from subzone β-mezosaprobic (β-m), where the oxidation processes are predominant compared to those of reduction, the water being considered slightly polluted.

CONCLUSIONS

Vâlsan Lake phytoplankton is relatively poor, represented mainly by diatoms and a lower proportion of green algae. These two groups make up a specific phytoplankton association, characteristic for lakes located at high altitudes.

Biological diversity is reduced in Vâlsan Lake; there were found 55 phytoplankton species belonging to various systematic groups: Cyanobacteria, Dinophyta, Chrysophyta, Bacillariophyta, Chlorophyta.

Regarding the distribution of the number of taxa in longitudinal profile, the phytoplankton quality is poor in the upper section, at the bottom of the lake, due to abiotic conditions close to those of the river, becoming more diverse in species in the middle and lower sections of the lake.

REFERENCES

FRANCISC N. T. & BARNA A. 1998. *Alge verzi unicelulare (Chlorococcales) – Determinator.* Presa Universitară Clujeană. Cluj-Napoca. 200 pp.

HINDÁK F., KOMÁREK J., MARVAN P., RŮŽIČKA J. 1975. *Kľúč na určovanie výtrusných rastlín.* SPN Bratislava. 400 pp.

HORTOBAGYI T. 1973. *The microflora in the settling and subsoil water enriching basins of the Budapest waterworks – A comparative study in ecology, limnology and sistematics.* Akademiai Kiado Budapest. 340 pp.

HÖTZEL G. & CROOME R. 1999. *A phytoplankton methods manual for Australian freshwaters.* Land and Water Resources Research and Development Corporation. Canberra. 58 pp.

IONESCU AL. & PÉTERFI L. ŞT. 1979. *Tratat de algologie.* Edit. Academiei R.S.R., Bucureşti. **3**. 374 pp.

IONESCU AL. & PETERFI L. ŞT. 1981. *Tratat de algologie.* Edit. Academiei R.S.R., Bucureşti. **4**. 447 pp.

MĂLĂCEA I. 1969. *Biologia apelor impurificate – Bazele biologice ale protecţiei apelor.* Edit. Academiei R.S.R., Bucureşti. 237 pp.

UJVÁRI I. 1972. *Geografia apelor României.* Edit. Ştiinţifică, Bucureşti. 592 pp.

VLĂDUȚU ALINA–MIHAELA 2005. *Elemente de limnologie – Ecologia apelor curgătoare.* Edit. Universităţii din Piteşti. 136 pp.

Vlăduţu Alina – Mihaela
University of Piteşti
Str. Târgul din Vale, No. 1, 110040, Piteşti, Romania
E-mail: alina_vladutu@yahoo.com

Received: March 29, 2011
Accepted: August 8, 2011

THE ROLE OF THE DANUBE HYDROGRAPHIC BASIN IN THE DISTRIBUTION OF GASTROPODS WITHIN THE FAUNISTIC PROVINCES OF ROMANIA

CIOBOIU Olivia

Abstract. The paper presents preliminary data regarding the patrimony of gastropods from the main rivers of the Danube hydrographic basin, which are specific to the zoogeographical provinces of Romania. It is highlighted the fact that there have been identified 82 species of gastropods in the continental water bodies. The distribution of the species in the five provinces is as it follows: Dacian – 8 species, Moessic – 17 species, Pannonian – 2 species, Pontic – 21 species, and Moldavian – 1 species. As number of species, there predominated the gastropods from the Pontic and Moessic provinces, which emphasizes that the gastropods spreading centre within Romania is the Danube, the Danube Floodplain, and the Danube Delta.

Keywords: gastropods, Danube, faunistic provinces, Romania.

Rezumat. Rolul bazinului hidrografic al Dunării în răspândirea gastropodelor în provinciile faunistice din România. Lucrarea prezintă date asupra patrimoniului gastropodelor din principalele râuri ale bazinului hidrografic al Dunării, specifice provinciilor zoogeografice din România. Se evidenţiază că în apele continentale au fost identificate un număr de 82 specii gastropode. Răspândirea speciilor în cele 5 provincii este: Dacică – 8 specii, Moesică – 17 specii, Panonică – 2 specii, Pontică – 21 specii şi Moldavă – 1 specie. Au dominat prin număr de specii gastropodele din provinciile Pontică şi Moesică, ceea ce arată că centrul de răspândire al gastropodelor în ecosistemele acvatice de pe teritoriul României este Dunărea, zona inundabilă şi Delta Dunării.

Cuvinte cheie: gastropode, Dunăre, provincii faunistice, România.

INTRODUCTION

The Danube hydrographic basin within Romania comprised 15 hydrographic basins of the main tributary rivers (ARDELEAN et al., 1964; BREZEANU & GRUIŢĂ, 2002) (Fig. 1). The total number of gastropods identified in the river system reaches 82 species (CIOBOIU, 2003; 2006; 2008). Analysing the figure below, we notice that the highest number of species is characteristic to the Danube, while in the other hydrographic basins the number is relatively uniform, varying between 54 and 28 species: 1. The upper Tisa – 30 species; 2. The Someş – 30 species; 3. The Crişuri rivers – 39 species; 4. The Mureş – 35 species; 5. The Bega, the Timiş, the Caraş – 54 species; 6. The Nera, the Cerna – 51 speies; 7. The Jiu – 28 species; 8. The Olt – 31 species; 9. The Vedea – 29 species; 10. The Argeş – 29 species; 11. The Ialomiţa – 31 species; 12. The Siret – 29 species; 13. The Prut – 31 species; 14. The Danube – 113 species (54 species along the Romanian sector); 15. The shore area – 96 species (82 species on the continental platform of the Black Sea, the Romanian sector). These species cover a specific space within the biogeographic provinces of Romania.

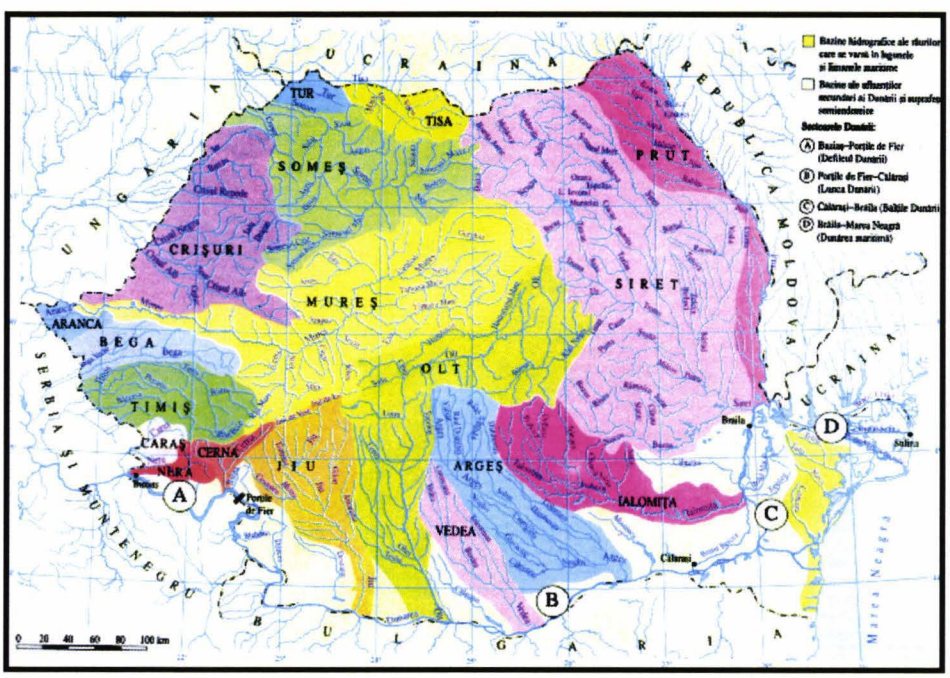


Figure 1. Distribution of gastropods within the hydrographical basins of Romania (after DRUGESCU, 1994).
Figura 1. Distribuţia gastropodelor în bazinele hidrografice din România (după DRUGESCU, 1994).

By analysing the position of the hydrographic basins of the main rivers, it results that the Danube and the lower sectors of the Jiu, the Olt, the Argeş, the Ialomiţa rivers belong to the Moessic province. The lower sector of the Danube, starting from the mouth of the Argeş and the lower part of the Siret basin, as well as the small streams from Dobroudja belong to the Pontic province. Most of the rivers from Romania are located within the Dacian province. Among these, we mention the Mureş, the upper sectors of the main tributaries of the Danube (the Jiu, the Olt, the Argeş, the Ialomiţa). The Prut River is placed in the Moldavian province, while the Crişuri rivers, the Bega, the Nera, the Caraş, the Cerna rivers are included in the Pannonian province (BĂNĂRESCU, 1970; CĂLINESCU et al., 1972) (Fig. 2).

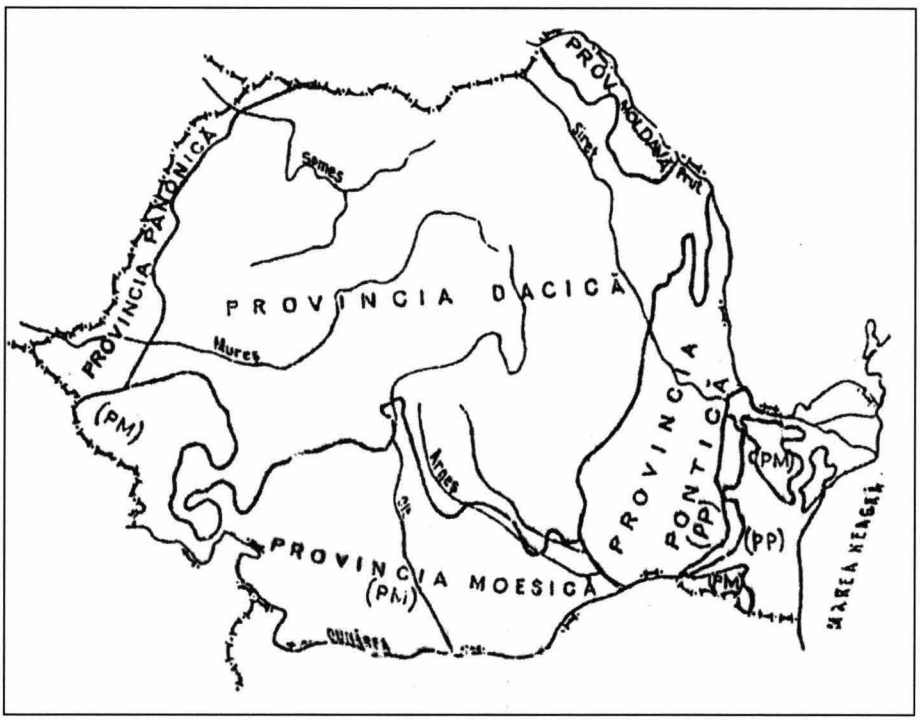


Figure 2. Biogeographic regions of Romania (after CĂLINESCU et al., 1972).
Figura 2. Regionarea biogeografică a României (după CĂLINESCU et al., 1972).

MATERIAL AND METHODS

In order to globally evaluate the diversity and distribution of the species, there was performed an inventory of the aquatic gastropods patrimony in the five Romanian faunistic provinces. For rendering the specific features of the aquatic ecosystems gastropods live in and emphasizing their distribution within the zoogeographical provinces, there were taken qualitative and quantitative samples from the Danube and its tributaries, the Jiu, the Olt, and the Argeş. Within this framework, it has been achieved a synthesis of the zoogeographical distribution of the fresh water gastropods on the territory of Romania for the first time (BĂNĂRESCU, 1990; BĂNĂRESCU & BOŞCAIU, 1973; COSTACHE, 1996; DRUGESCU, 1994).

RESULTS AND DISCUSSIONS

Following the distribution of the gastropods on faunistic provinces, it results that out of the total number of 82 species located within all the rivers, 8 species are characteristic to the Dacian province, 17 to the Moessic province, 2 to the Pannonian province, 21 to the Pontic province, and one species to the Moldavian province (Table 1).

Table 1. Distribution of the gastropods characteristic to the faunistic provinces of Romania.
Tabel 1. Răspândirea gastropodelor caracteristice în provinciile faunistice din România.

No.	Species	Faunistic provinces of Romania				
		Dacian	Moessic	Pannonian	Pontic	Moldavian
1.	*Theodoxus (Th.) danubialis* (C. PFEIFFER 1828)	+	+	+	+	+
2.	*Theodoxus (Th.) d. stragulatus* (C. PFEIFFER 1828)		+			
3.	*Theodoxus (Th.) euxinus* (CLESSIN 1887)				+	
4.	*Theodoxus (Th.) fluviatilis* (LINNAEUS 1758)		+		+	
5.	*Theodoxus (Th.) pallasi* LINDHOLM 1924				+	
6.	*Theodoxus (Th.) prevostianus* (C. PFEIFFER 1828)			+		
7.	*Theodoxus (Th.) transversalis* (C. PFEIFFER 1828)		+	+	+	
8.	*Viviparus acerosus* (BOURGUIGNAT 1862)	+	+	+	+	+
9.	*Viviparus contectus* (MILLET 1813)	+			+	

10.	*Viviparus viviparus* (LINNAEUS 1758)		+		+	
11.	*Valvata (Cincinna) piscinalis* (O. F. MULLER 1774)	+	+	+	+	+
12.	*Valvata (Cincinna) piscinalis antiqua* MORRIS 1838		+			
13.	*Valvata (Valvata) cristata* O. F. MULLER 1774	+				+
14.	*Borysthenia naticina* (MENKE 1845)		+		+	
15.	*Pseudamnicola (P.) dobrogica* GROSSU 1986				+	
16.	*Pseudamnicola (P.) leontina* GROSSU 1986				+	
17.	*Pseudamnicola (P.) penchinati* (BOURGUIGNAT 1870)				+	
18.	*Pseudamnicola (P.) razelmiana* GROSSU 1986				+	
19.	*Pseudamnicola (P.) bacescui* GROSSU 1986				+	
20.	*Grossuana codreanui* GROSSU 1946				+	
21.	*Paladilhia (Paladilhiopsis) transsylvanica* ROTARIDES 1943	+				
22.	*Paladilhia (Paladilhiopsis) carpathica* SOOS 1940	+				
23.	*Paladilhia (Paladilhiopsis) leruthi* C. R. BOETGER 1940	+				
24.	*Bythinella austriaca* (FRAUENFELD 1857)	+				
25.	*Bythinella a. melanostroma* BRANCSIK 1889				+	
26.	*Bythinella dacica* (GROSSU 1946)	+				
27.	*Bythinella grossui* FALNIOWSKI, SZAROWSKA & SÎRBU 2009	+				
28.	*Bythinella molcsany* (J. WAGNER 1941)	+				
29	*Potamopyrgus jenkinsi* (SMITH 1889)				+	
30.	*Lithoglyphus apertus* (KUSTER 1852)		+			
31.	*Lithoglyphus naticoides* (C. PFEIFFER 1828)	+	+	+		
32.	*Lithoglyphus pygmaeus* FRAUENFELD 1863		+			
33.	*Bithynia (Bithynia) tentaculata* (LINNAEUS 1758)	+	+	+	+	+
34.	*Bithynia (Codiella) leachii* (SHEPPARD 1823)	+	+	+	+	+
35.	*Bithynia (Codiella) troschelli* (PAASCH 1842)		+		+	
36.	*Turricaspia (Clessiniola) variabilis* (EICHWALD 1838)				+	
37.	*T. (Laevicaspia) lincta* (MILASCHEWITCH 1908)				+	
38.	*T. (Oxypyrgula) ismailensis* (GOL. & STAROB. 1966)				+	
39.	*T. (Turricaspia) dimidiata* (EICHWALD 1841)				+	
40.	*T. (Micromelania) ostroumovi* (GOL. & STAROB. 1966)				+	
41.	*Melanopsis parreyssi* PHILIPPI 1847			+		
42.	*Esperiana esperi* (A. FERUSSAC 1823)	+	+	+	+	+
43.	*E. (Microcolpia) daudebardii* (PREVOST 1821)	+	+	+	+	+
44.	*E. (Microcolpia) daudebardii acicularis* (FERUSSAC 1823)		+		+	
45.	*Amphimelania holandri* (C. PFEIFFER 1828)		+			
46.	*Physa fontinalis* (LINNAEUS 1758)	+	+	+	+	+
47.	*Physella (Costatella) acuta* (DRAPARNAUD 1805)	+	+	+	+	+
48.	*Aplexa hypnorum* (LINNAEUS 1758)	+	+	+	+	+
49.	*Lymnaea stagnalis* (LINNAEUS 1758)	+	+	+	+	+
50.	*Stagnicola corvus* (GMELIN 1791)	+	+	+	+	+
51.	*Stagnicola palustris* (O. F. MULLER 1774)	+	+	+	+	+
52.	*Stagnicola turricula* HELD 1836	+		+		
53.	*Radix ampla* (W. HARTMANN 1821)		+	+	+	
54.	*Radix auricularia* (LINNAEUS 1758)	+	+	+	+	+
55.	*Radix balthica* (LINNAEUS 1758)	+	+	+	+	+
56.	*Radix labiata* (ROSSMASSLER 1835)	+	+	+	+	+
57.	*Galba truncatula* (O. F. MULLER 1774)	+	+	+	+	+
58.	*Ancylus fluviatilis* O. F. MULLER 1774		+		+	
59.	*Ferrissia (Pettancylus) clessiniana* (JICKELI 1882)		+		+	
60.	*Acroloxus lacustris* (LINNAEUS 1758)	+	+	+	+	+
61.	*Planorbis (Planorbis) carinatus* O. F. MULLER 1774	+	+	+	+	+
62.	*Planorbis (Planorbis) planorbis* (LINNAEUS 1758)	+	+	+	+	+
63.	*Biomphalaria tenogophila* (ORBIGNY 1835)		+		+	
64.	*Anisus (Anisus) calculiformis* (SANDBERGER 1874)					+
65.	*Anisus (Anisus) leucostoma* (MILLET 1813)	+	+			
66.	*Anisus (Anisus) septemgyratus* (ROSSMASSLER 1835)	+	+	+	+	+
67.	*Anisus (Anisus) spirorbis* (LINNAEUS 1758)	+	+	+	+	+
68.	*Anisus (Disculifer) vortex* (LINNAEUS 1758)	+	+	+	+	+
69.	*Anisus (Disculifer) vorticulus* TROSCHEL 1852		+	+	+	
70.	*Bathyomphalus contortus* (LINNAEUS 1758)	+	+	+	+	+
71.	*Gyraulus (Armiger) crista* LINNAEUS 1758	+	+	+	+	+
72.	*Gyraulus (Gyraulus) acronicus* (A. FERUSSAC 1807)	+	+	+	+	+
73.	*Gyraulus (Gyraulus) albus* (O. F. MULLER 1774)	+	+	+	+	+
74.	*Gyraulus (Torquis) laevis* (ALDER 1838)	+	+	+	+	+
75.	*Gyraulus (Lamorbis) rossmaessleri* (AUERSWALD 1852)		+		+	
76.	*Hippeutis complanatus* (LINNAEUS 1758)	+	+	+	+	+
77.	*Segmentina nitida* (O. F. MULLER 1774)	+	+	+	+	+
78.	*Planorbarius corneus* (LINNAEUS 1758)	+	+	+	+	+
79.	*Planorbella duryi* (WETHERBY 1879)		+		+	
80.	*Oxyloma (Oxyloma) dunkeri* (L. PFEIFFER 1865)		+		+	
81.	*Oxyloma (Oxyloma) elegans* (RISSO 1826)		+		+	
82.	*Oxyloma (Oxyloma) pinteri* GROSSU 1987		+	+	+	+

The Dacian Province is the largest zoogeographical unit on the territory of our country and includes the entire mountain region and partially the hilly region. Most of the species living in this province display a Central-European distribution. The main gastropods characteristic to the province are (GROSSU, 1946; GROSSU & NEGREA, 1984; FALNIOWSKI et al., 2009): *Valvata (V.) cristata* O. F. MULLER 1774, *Paladilhia (Paladilhiopsis) transsylvanica* ROTARIDES 1943, *P. (P.) carpathica* SOOS 1940, *P. (P.) leruthi* C. R. BOETGER 1940, *Bythinella austriaca* (FRAUENFELD 1857), *B. dacica* (GROSSU 1946), *B. grossui* FALNIOWSKI, SZAROWSKA & SÎRBU, 2009; *B. molcsany* (J. WAGNER 1941).

The Moessic Province includes the high and low plains, as well as the hilly or even the mountain regions from Banat, Oltenia, Muntenia and North and South Dobroudja. Most of the fauna present in this province is made up of species that usually live in the plain and hilly regions of the country and are common to all the zoogeographical provinces (GROSSU, 1955; BOTOŞĂNEANU & NEGREA, 1976). Aquatic gastropods developed in a significant number in this province. Thus, we mention the species – *Theodoxus (Th.) d. stragulatus* (C. PFEIFFER 1828), *Th. (Th.) transversalis* (C. PFEIFFER 1828), *Viviparus viviparus* (LINNAEUS 1758), *Valvata (Cincinna) piscinalis antiqua* MORRIS 1838, *Borysthenia naticina* (MENKE 1845), *Lithoglyphus apertus* (KUSTER 1852), *L. pygmaeus* FRAUENFELD 1863, *Bithynia (Codiella) troschelli* (PAASCH 1842), *Esperiana (Microcolpia) daudebardii acicularis* (FERUSSAC 1823), *Amphimelania holandri* (C. PFEIFFER 1828), *Physella (Costatella) acuta* (DRAPARNAUD 1805), *Stagnicola palustris* (O. F. MULLER 1774), *Radix ampla* (W. HARTMANN 1821), *R. labiata* (ROSSMASSLER 1835), *Galba truncatula* (O. F. MULLER 1774), *Ancylus fluviatilis* O. F. MULLER 1774, *Ferrissia (Pettancylus) clessiniana* (JICKELI 1882), *Biomphalaria tenogophila* (ORBIGNY 1835), *Anisus (Anisus) leucostoma* (MILLET 1813), *Anisus (Disculifer) vorticulus* TROSCHEL 1852, *Gyraulus (Gyraulus) albus* (O. F. MULLER 1774), *Gyraulus (Lamorbis) rossmaessleri* (AUERSWALD 1852), *Planorbella duryi* (WETHERBY 1879).

Ancylus fluviatilis, a specific reophilic form, was quite often identified on the river rocks in Banat, at the mouth of the Danube tributaries (BĂNĂRESCU & SÎRBU, 2002). *Radix ampla* and *R. labiata*, more or less limnophilous species, appear in the areas with still water, where aquatic vegetation finds appropriate development conditions. In the springs located on the valleys of the Mraconia and Berzeasca rivers, the species *Radix labiata* was identified in a biocoenosis on the sandy bottoms in moss.

In the components of the biocoenoses from permanent or temporary stagnant waters, gastropods make up relatively dense populations, which develop in almost all the pools located in the Iron Gates area. In this province, there were also identified the species belonging to the *Planorbis* and *Anisus* genus, as well as the species *Amphimelania holandri* (NEGREA, 1994).

The Pannonian Province is located in Banat-Crisana Plain, in the west of our country. In terms of age, it is younger than the Dacian province. From the physical-geographical point of view, it covers a flat surface with forest steppe vegetation (oak forests, Turkish and Hungarian oak alternating with gramineous plants), rivers characterized by a high discharge and a moderate continental climate (BOTOŞĂNEANU & NEGREA, 1976; BĂNĂRESCU & ARION, 1982; GROSSU, 1986). The gastropods from this province are represented by the species *Theodoxus (Th.) prevostianus* (C. PFEIFFER 1828) and *Melanopsis parreyssi* PHILIPPI 1847.

The Pontic Province covers the low plain and hilly regions from Bărăgan, Dobroudja Plateau, and Covurlui Plain (GROSSU, 1939; CIOBOIU, 2003). In this province, there were identified the most numerous aquatic gastropod species from Romania – *Theodoxus (Th.) euxinus* (CLESSIN 1887), *Th. (Th.) fluviatilis* (LINNAEUS 1758), *Th. (Th.) pallasi* LINDHOLM 1924, *Viviparus contectus* (MILLET 1813) (Ponto-Dacian species), *Pseudamnicola (P.) dobrogica* GROSSU 1986, *P. (P.) leontina* GROSSU 1986, *P. (P.) penchinati* (BOURGUIGNAT 1870), *P. (P.) razelmiana* GROSSU 1986, *P. (P.) bacescui* GROSSU 1986, *Grossuana codreanui* GROSSU 1946, *Bythinella a. melanostroma* BRANCSIK 1889, *Potamopyrgus jenkinsi* (SMITH 1889), *Turricaspia (Clessiniola) variabilis* (EICHWALD 1838), *T. (Laevicaspia) lincta* (MILASCHEWITCH 1908), *T. (Oxypyrgula) ismailensis* (GOL. & STAROB. 1966), *T. (Turricaspia) dimidiata* (EICHWALD 1841), *T. (Micromelania) ostroumovi* (GOL. & STAROB. 1966), *Esperiana esperi* (A. FERUSSAC 1823), *Hippeutis complanatus* (LINNAEUS 1758), *Oxyloma (O.) dunkeri* (L. PFEIFFER 1865), *O. (O.) elegans* (RISSO 1826), *O. (O.) pinteri* GROSSU 1987.

The Moldavian Province (Sarmatic) presents a fauna characteristic to forest steppe regions (GROSSU, 1987). Among gastropods, we mention *Anisus (A.) calculiformis* (SANDBERGER 1874).

The endemic species hold a great share in the total number of gastropods. Even if there spreading area is limited, there are rich populations (GROSSU, 1993; Fauna Europaea, 2005). These are elements that originate in Romania and so far they have been identified only in our country, the decisive role being played by the Danube hydrographic basin. Among these species, we mention:

- **endemic species within the Pontic Province**: *Theodoxus (Th.) euxinus* (CLESSIN 1887), *Th. (Th.) pallasi* LINDHOLM 1924 (ponto-caspică), *Pseudamnicola (P.) dobrogica* GROSSU 1986, *P. (P.) leontina* GROSSU 1986, *P. (P.) penchinati* (BOURGUIGNAT 1870), *P. (P.) razelmiana* GROSSU 1986, *P. (P.) bacescui* GROSSU 1986, *Grossuana codreanui* GROSSU 1946, *Turricaspia (Laevicaspia) lincta* (MILASCHEWITCH 1908), *T. (Oxypyrgula) ismailensis* (GOL. & STAROB. 1966), *T. (Turricaspia) dimidiata* (EICHWALD 1841);
- **Ponto-Danubian endemic species**: *Theodoxus (Th.) danubialis* (C. PFEIFFER 1828), *Th. (Th.) transversalis* (C. PFEIFFER 1828), *Borysthenia naticina* (MENKE 1845) (Ponto-Danubian-Baltic species), *Viviparus viviparus* (LINNAEUS 1758), *Lithoglyphus naticoides* (C. PFEIFFER 1828) (endemic species in the Danube basin), *L. apertus*

(KUSTER 1852), *L. pygmaeus* FRAUENFELD 1863, *Bithynia (Codiella) troschelli* (PAASCH 1842), *Amphimelania holandri* (C. PFEIFFER 1828), *Oxyloma (O.) pinteri* GROSSU 1987);

- **endemic species within the Dacian Province**: *Paladilhia (Paladilhiopsis) transsylvanica* ROTARIDES 1943, *P. (P.) carpathica* SOOS 1940, *P. (P.) leruthi* C. R. BOETGER 1940, *Bythinella dacica* (GROSSU 1946), *B. grossui* FALNIOWSKI, SZAROWSKA & SÎRBU 2009, *B. molcsany* (J. WAGNER 1941);
- **endemic species within the Pannonian Province**: *Melanopsis parreyssi* PHILIPPI 1847.

Relict species are old species that develop on extremely reduced areas. Some of them are near extinct. Among the relict Pontic-Caspian species, we mention: *Theodoxus (Th.) prevostianus* (C. PFEIFFER 1828), *Borysthenia naticina* (MENKE 1845), *Turicaspia (Micromelania) ostroumovi* (GOL. & STAROB. 1966), *Melanopsis parreyssi* PHILIPPI 1847, *Amphimelania holandri* (C. PFEIFFER 1828).

A particular category is represented by **immigrant species**, which come from the neighbouring areas, extending their geographical area and, many times, replacing the local species. The most representative gastropods are: *Theodoxus (Th.) danubialis* (C. PFEIFFER 1828), *Th. (Th.) fluviatilis* (LINNAEUS 1758), *Viviparus acerosus* (BOURGUIGNAT 1862), *Valvata (Cincinna) piscinalis* (O. F. MULLER 1774), *Esperiana esperi* (A. FERUSSAC 1823), *Ancylus fluviatilis* O. F. MULLER 1774.

From the analysis of the Danube hydrographical basin, we may notice that the distribution of the 82 species within the river system of Romania is relatively uniform. This can be explained through the unitary, integrative character of the river system, the main role being played by the Danube, its floodplain, and the Danube Delta, where there were identified the most numerous species (CIOBOIU, 2010; NEGREA, 1994).

CONCLUSIONS

In the continental water bodies from Romania, there were identified 82 species belonging to two large systematic groups: 45 Prosobranchiata and 37 Pulmonata. From the analysis of the species distribution in the five faunistic provinces, it results that there predominated the gastropods characteristic to Pontic and Moessic provinces, 45 species, due to the density of the river system.

We may conclude that the distribution centre of gastropods in the aquatic ecosystems from Romania is the Danube, its floodplain, and the Danube Delta, due to the diversity of ecosystem types (streams, lakes, pools, swamps) integrated within this zoogeographical space. The origin of the species characteristic only to the faunistic provinces is more or less linked to the Danube, its floodplain, and the Danube Delta.

REFERENCES

ARDELEAN I., BANU C. A., BREZEANU GH., BUŞNIŢĂ TH. 1964. *Limnology of the Romanian sector of the Danube.* Romanian Academy Publishing House. Bucharest. 420 pp. [In Romanian].

BĂNĂRESCU P. 1970. *Principii şi probleme de zoogeografie.* Edit. Academiei Române. Bucureşti. 260 pp.

BĂNĂRESCU P. 1990. *Zoogeography of freshwaters General Distribution and Dispersal of Freshwater Animals.* AULA-Verlag. Wiesbaden. **1**: 303–360.

BĂNĂRESCU P. & BOŞCAIU N. 1973. *Biogeografie.* Edit. Ştiinţifică. Bucureşti. 302 pp.

BĂNĂRESCU P. & ARION ELENA P. 1982. *Zoocenoza de moluşte prosobranhiate din râul Caraş şi necesitatea protejării ei.* Conferinţa Naţională de Ocrotirea naturii. Drobeta-Turnu-Severin: 155–159.

BĂNĂRESCU P. & SÎRBU I. 2002. *Contribution to the knowledge of the Banat aquatic fauna biodiversity.* Studies in Biodiversity-West Romania-Protected Areas. Timişoara: 108–115.

BOTOŞĂNEANU L. & NEGREA ALEXANDRINA. 1976. *Sur quelques aspects biologiques d'une riviere des monts du Banat-Roumanie: la Nera (et surtout sur une remarquable association de gastropodes).* Revista Hidrobiologia. Bucureşti. **15**(3): 403–432.

BREZEANU GH. & GRUITA ALEXANDRA S. 2002. *Limnologie generală.* Edit. H.G.A. Bucureşti. 287 pp.

CĂLINESCU R., BUNESCU A., PĂTROESCU MARIA. 1972. *Biogeografie.* Edit. Didactică şi Pedagogică. Bucureşti. 242 pp.

CIOBOIU C. OLIVIA. 2003. *Gastropodele din apele continentale ale României si zona litorală a Mării Negre.* Edit. Sitech. Craiova. 95 pp.

CIOBOIU OLIVIA. 2006. *Diversity of the Gastropods along the lower sector of the Danube and its neighbouring areas.* Lymnological Reports. Viena. **36**: 99–103.

CIOBOIU OLIVIA. 2008. *The distribution of the gastropoda populations from the Danube and Danube Delta.* Verh. Internat. Verein. Limnol. Stuttgart. **30**(2): 295–296.

CIOBOIU OLIVIA. 2010. *Gastropoda in the Danube – Carpathian hydrographic space: possible impact of climate change.* Lymnological Reports. Dresden. **38**: 67–73.

COSTACHE N. 1996. *Regionarea biogeografică a României.* Edit. Universităţii din Bucureşti. 319 pp.

DRUGESCU C. 1994. *Zoogeografia României.* Edit. ALL. Bucureşti. 140 pp.

FALNIOWSKI A., SZAROWSKA MAGDALENA, SÎRBU I. 2009. *Bythinella Moquin-Tandon, 1856 (Gastropode: Rissooidea: Bythinellidae) in Romania: its morphology with description of four new species.* Folia Malacologica. Poznan. **17**(1): 33–48.

GROSSU AL. V. 1939. *Contribuţiuni la studiul repartiţiei geografice a moluştelor în România.* Revista geografică română. Bucureşti. **2**(2-3): 1–11.

GROSSU AL. V. 1946. *Contribution à la faune malacologique de Roumanie: sur deux espéces nouvelles de Hydrobiidae: Paladilhiopsis codreanui n. sp., Bythinella dacica n. sp.* Academia Română. Buletin Ştiinţific. Bucureşti. **29**(3): 203–206.

GROSSU AL. V. 1955. *Contribuţiuni sistematice şi zoogeografice la cunoaşterea gastropodelor din Valea Minişului Banat*, Comunicările Academiei R.P.R. **5**(4): 665–699.

GROSSU AL. V. 1986. *Gastropoda Romaniae, 1. Subclasa Prosobranchia şi Opistobranchia.* Edit. Litera. Bucureşti. 525 pp.

GROSSU AL. V. 1987. *Gastropoda Romaniae, 2. Subclasa Pulmonata I. Ordo Basommatophora II. Ordo Stylommatophora.* Edit. Litera. Bucureşti. 445 pp.

GROSSU AL. V. 1993. *The catalogue of the molluscs from Romania.* Travaux du Museum d'Histoire Naturelle "Grigore Antipa''. Bucureşti. **33**: 291–366.

GROSSU AL. V. & NEGREA ALEXANDRINA. 1984. *Nouvelles donnees sur la presence du genre Paladilhia Bourguignat, 1865 (Gastropoda Prosobranchia, Moitessieriidae) en Roumanie.* Travaux du Museum d'Histoire naturelle "Grigore Antipa''. Bucureşti. **25**: 47–49.

NEGREA ALEXANDRINA. 1994. *Contribution a l'etude faunistique et biogeographique des Gastropodes du secteur roumain du Danube.* Annals. Limnological. Toulouse. **30**: 179–195.

***. Fauna Europaea. *www. Faunaeur.org.* (accesed: April 5, 2011).

Cioboiu Olivia
The Oltenia Museum, Craiova, Str. Popa Şapcă,
No. 8, 200422, Craiova, Romania
E-mail: cioboiuolivia@yahoo.com

Received: March 17, 2011
Accepted: August 28, 2011

CONSERVATION OF VALUABLE LANDSCAPE FROM THE BASIN OF THE PRUT RIVER (THE REPUBLIC OF MOLDOVA)

LIOGCHII Nina, BEGU Adam, BREGA Vladimir, DONICA Ala

Abstract. The study includes research on the status of representative ecosystems of the Basin of the Prut River: Landscape Reserve (LR) - Suta de Movile, Geology and Palaeontology Nature Monument (GPNM) – Gorge Duruitoarea and Natural Forest Reserve (NFR) - Şaptebani. The study assessed the overall environmental condition, identified and assessed the sources and the level of pollution of environmental components, registered and described the species of flora and fauna, identified the rare species which are protected nationally and internationally. Based on the investigation parameters, it was concluded that the investigated objects are in good ecological state and serve as a favourable habitat for many rare species of flora and fauna, with national and international protection status. Water quality of the Duruitoarea and the Ciugureţ rivers, which cross NFR Şaptebani and GPNM Gorge Duruitoarea correspond to class II of surface water quality. The impact from local and transboundary sources of pollution, calculated based on the amounts of pollutants emitted, is insignificant. The inseparable interdependence between abiotic and biotic factors of ecosystems comes to convince about the need to protect landscapes as a whole, integrally, both geological and hydrological elements and flora and fauna species, a requirement stipulated by European Landscape Convention, Florence, 2000. The presented material serves as scientific a support to argue the protection category of investigated objects.

Keywords: landscape, state protected area, valuable species, geological objects, water resources.

Rezumat. Conservarea unor peisaje valoroase din bazinul râului Prut (Republica Moldova). Studiul include cercetări privind starea unor ecosisteme reprezentative din bazinul râului Prut: Rezervaţia Peisajeră (RP) – Suta de movile, Monumentul Naturii Geologic şi Paleontologic (MNGP) – Defileul Duruitoarea şi Rezervaţia Naturală Silvică (RNS) - Şaptebani. A fost apreciată starea ecologică generală, stabilite sursele şi nivelul de poluare a componentelor de mediu din ecosistemele studiate, descrisă vegetaţia şi înregistrate speciile de floră şi faună, cu evidenţierea celor rare şi protejate la nivel naţional şi internaţional. În baza indicilor investigaţi s-a constatat că obiectele cercetate se caracterizează printr-o stare ecologică bună şi servesc ca habitate favorabile pentru multe specii rare de floră şi faună, cu statut naţional şi internaţional de protecţie. Calitatea apei din râuleţele Ciugureţ şi Duruitoarea, pe sectoarele ce traversează RNS Şaptebani şi MNGP Defileul Duruitoarea, corespunde clasei a II-a pentru apele de suprafaţă. Impactul de la sursele locale şi transfrontaliere de poluare, calculat în baza cantităţilor de noxe emise, este nesemnificativ. Interdependenţa inseparabilă dintre factorii abiotici şi biotici ai ecosistemelor vine să convingă despre necesitatea protejării peisajelor în ansamblu, incluzând atât elementele geologice şi hidrologice, cât şi bogăţia floristică şi faunistică specifică, obligaţiune stipulată şi de Convenţia privind Peisajul European, Florenţa, 2000. Materialul prezentat serveşte drept suport ştiinţific pentru argumentarea categoriei de protecţie a obiectelor menţionate.

Cuvinte cheie: peisaj, Arie Naturală Protejată de Stat, specii valoroase, obiective geologice, surse de apă.

INTRODUCTION

One of the most valuable components of the natural heritage of any state is the natural landscape. Although created already for centuries, the landscape is subject to profound and continuous change caused for instance by changes in climate but also ever increasing human impact. Particularly, in the recent years, this becomes increasingly apparent, endangering the existence of natural ecosystems, which are an integral part of the landscapes. Thus, conservation of these and particularly of those more sensible to human and non-human origin changes is essential. This concept is relevant for countries with a fairly small share of protected areas, such as the Republic of Moldova (157 227.4 hectares or 4.65% of the country). In this context, and as a result of subsequent documents adopted by Rio Convention on Biological Diversity (1992), which promotes conduction of complex studies and that protected areas should be expansion of up to 12% of the country.

The Moldavian rate remains insufficient to ensure a balance of all its components, good functioning of the ecosystem and performance of conservation measures for preserving biodiversity. Moreover, most categories of protected areas in the Republic of Moldova promote conservation of only certain elements: i.e. species of plants, animals but not all the basic components of an ecosystems (i.e. soil, substrate, water, air, biota, etc.), let alone the whole landscape. In this respect, the Ecobioindication and Radioecology laboratory of the Institute of Ecology and Geography, evaluated a range of representative ecosystems located within the Prut River Basin during the period 2004-2008 with the aim to assess the environmental status and quality of ecosystem abiotic components, the presence of landscape elements (monumental rocks, waterfalls, caves, meadows, hills, steppe, etc.) representative species of plants and animals, with nationally and internationally protection status.

MATERIAL AND METHODS

The study of the ecosystems was conducted in field conditions, by describing the flora and fauna species in different seasons (spring, summer, autumn), photography of objects/species and water, mud, rocks and shells sampling.

Assembling of the herbarium and the collection of animal samples was done in line with the provisions of the traditional methods (IVAN & DONIȚĂ, 1975) and species taxonomic belonging/affiliation determined with the help of specialised books for higher plants, mosses, lichens, molluscs and algae (BEGU et al., 2005; GHEIDEMAN, 1975; NEGRU et al., 2002; SIMONOV, 1978; MUNTEANU & LOZAN, 2004; GROSSU, 1986), using microscopes MBS-10 and Micmed-5.

The establishment of the protection level of rare species was done in accordance with: field drafts, Red Books and Lists and Annexes of Environmental Conventions: Washington (1973), Bern (1979), Bonn (1979), taking into account the IUCN categories.

The heavy metal content was determined by Atomic Absorption Method – AAS and Fluorescent roenthgen-spectrometry (OBUHOV & ZĂRIN, 1977). Collection and analysis of water samples was performed using classical chemical methods. The characteristic of air pollution sources and quantities of pollutants emitted was gathered based on information available from the Yearbooks of the Statistics Departments and data on transboundary pollution obtained from EMEP program.

Given the fact that the accumulated information will serve for the development of Ecosystem/Protected Area Environmental Passport, methodological guidance and information on Passport development was also taken into consideration (POSTOLACHE et al., 2004).

RESULTS AND DISCUSSIONS

The Landscape Reserve (LR) – Suta de Movile, Geology and Palaeontology Nature Monument (GPNM) - Duruitoarea Gorge and Natural Forest Reserve (NFR) - Şaptebani are located in the northwestern part of the Republic of Moldova, Rîşcani district in the Prut River Basin, on various forms of relief underlying a less anthropogenic regional landscape (Fig. 1). According to the Law on State Protected Natural Areas Fund, these are assigned different categories of protection.

Landscape diversity is determined by geographical location, climate, geological composition, interaction with other regions as well as the influence of anthropogenic factors. According to the country landscape regions (PROCA, 1978), the territories under investigation are located in the steppe plateau region of the northwestern part of the Republic of Moldova, at the contact of two sub regions – pre Prut sub region, with dark grey and typical chernozem soils and Ciuhur plain, formed by deposits of clay, with typical chernozem.

Specific for the Prut terraces, particularly for hilly regions are landslides which have increased recently in LR Suta de Movile, due to the excess of moisture and clay substrate, favouring the emergence in lower areas of lakes and marshes. This process leads to the formation of mounds rows, parallel to the Prut River (LEVADNIUC, 1978).

The diffusion of the Prut River into the plain relief of the toltre chains, which were carved by exogenous factors, have led to the formation of gorges, grottoes and caves, one of which is Duruitoarea gorge, formed in limestone rocks, with steep slopes. The lowering of the Preprut River plain foundation in some regions of North and East allowed in those parts with lower altitude for the water to accumulate. In similar condition is the NFR Şaptebani, which in the lowest altitudes is crossed by the Ciuhureț River and is surrounded by limestone cliffs, eroded and carved by exogenous forces as well, where rich petrophyte vegetation is developed which serve as habitat for various animals species.

The studied objects, in terms of geographic location, are not surrounded by large industrial complexes or densely populated urban areas. Human impact occurs only during collecting plants activities, animals grazing, which do not appreciably disturb the ecological balance of protected areas from the region. The exception is GPNM Suta de Movile, as sometimes the area is subject to intense valuation.

Climate Features. In analysing the current state of investigated objects it is necessary to know the particular climatic conditions of the study period because climatic factors have left their mark on these. Thus, total annual solar radiation is 108-114 kcal/cm^2, and the average hours of sun shining is 2,100-2,200. Annual average temperature for this region is +9.5°C and the amount of precipitation is 556,0 mm (CONSTANTINOV et al., 2006).

The comparative analysis of meteorological data showed that the thermal and rainfall indices during the research period did not vary significantly from the average annual values (1900-1985). The north-west winds are predominant, followed by northern, south-east and southern ones. The wind direction is greatly influenced by landscape fragmentation. In the area with investigated objects, the north-west and south-east winds are frequent. Annual average wind speed is 3-5 m/sec, the maximum being registered in winter and spring seasons and the minimum in summer and autumn period. The winds speed and direction determines as well the transfer of air pollutants.

The hydrographical network of the investigated area is well developed and is represented by small rivers with low water flow and due to the groundwater supply many of them have a constant flow (BOBOC & MELNICIUC, 2006.).

The **human impact** is manifested in particular by emissions from adjacent pollution sources which are located about 15-30 km, originating from municipal heating plants and traffic. The main emissions from stationary local sources are: dust (65.9 t/year), SO_2 (14.7 t/year), NOx (2.5 t/year) and an insignificant amount of other pollutants. According to the EMEP data through precipitation, as a result of local and transboundary pollution, 45 kg/ha/year of SO_2 and 78 kg/ha/year settle annually, NOx and Pb and Cd deposition are 13.9 and 260 mg/ha/year, respectively. According to the normative OND-86 MAC for NOx and SO_2 from local sources of air pollution at ground level is 0.05 - 0.1 mg/m^3 air, thus representing an unimportant value.

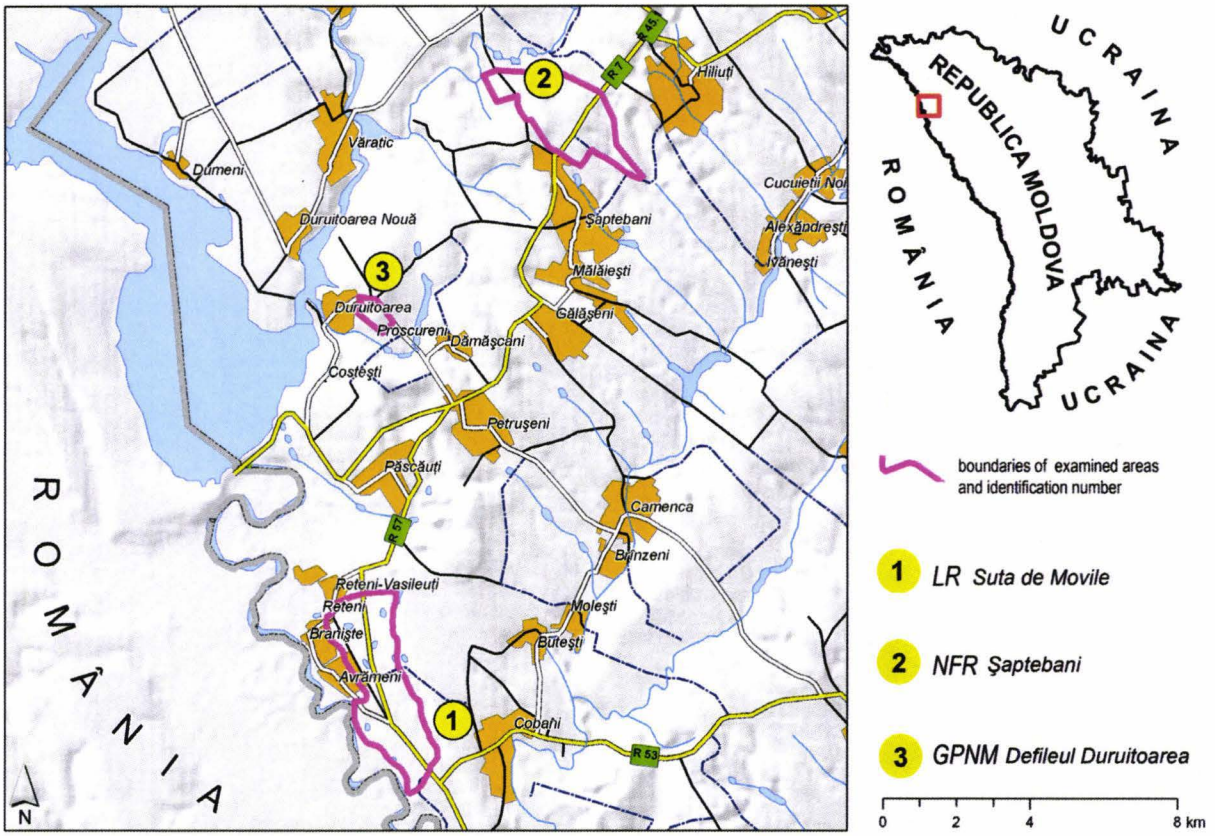


Figure1. The scheme location of investigated objects. / Figura 1. Schema amplasării obiectivelor studiate.

LR Suta de Movile, with an area of 1,058.24 hectares, is located between the villages Branişte and Cobani (Glodeni district) Rîşcani Forestry Detour. The territory of the landscape reserve Suta de Movile belongs to the steppe zone, agropedology district with levigated and typical chernozem of the forest steppe plateau and sub-district with ordinary and carbonate chernozem and alluvial soils of the Prut River floodplain. The soil cover of the reservation was formed on the substrate of earlier massive landslides.

The results of heavy metal content in soil show concentrations that did not exceed the admissible levels. Across the entire hills there can be encountered mounds with micro- and meso- depressions in which water accumulates, forming puddles. Along the western side, there is a steep slope, characteristic for a landslide feature. Such relief influence on distribution of surface and groundwater water, the processes of erosion, salinization, formation of swamps and marshes (URSU, 2006).

Along with the emission impact from the local and cross-border pollution sources, the human impact is manifested through capitalization of land for agriculture and grazing practice, mainly in the areas between the so-called "mounds". The main type of use of these sectors is the cultivation of wheat and corn, partially of sugar beet. The agrocoenoses were created by grubbing of grassland areas, both on plain and steep slopes, which have accelerated soil erosion and landslides. Currently, steppe formations, dominated by feather grass, in rich blend with other hygro-and mesophilous herbs are heavily degraded as a result of grazing.

The study of the flora shows that along the usual steppe vegetation: *Stipa pulcherrima* L., *S. lessingiana* L., *S. capillata* L., *Festuca valesiaca* L. and other herbs which preserved on unused sectors, there are species of plants with national and international status of protection (Fig. 2). Among them we mention: *Vinca minor* L., *Iris hungarica* WALDST. ET KIT, *Stipa pulcherrima* L. and *Hyacynthella leucophaea* (C. KOCH.) SCHUR, which besides being rare species under state protection are also included in Red Book of Ukraine (RBU) (i.e. *Stipa pulcherrima* L.) and Red Book of Romania (RBR) (i.e. *Hyacynthella leucophaea* (C. KOCH.) SCHUR). Of particular attention is *Pulsatilla montana* (HOPE) REICHEINB., which is a rare species for the Republic of Moldova flora and is included in the RBR, RLE, and Appendix I of Bern Convention (1979). In addition, the species *Pulsatilla montana* (HOPE) REICHEINB. is a limestone-loving species, which can serve as an indicator of calcareous substrate. More frequently there are encountered *Vinca minor* L., *Iris hungarica* WALDST. et KIT, and *Adonis vernalis* L., forming clusters and sectors from 2-3 to 10-25 m^2. Fairly isolated and sometimes even solitary there are clumps of *Stipa pulcherrima* L., *Hyacynthella leucophaea* (C. KOCH.) SCHUR., *Pulsatilla montana* (HOPE) REICHEINB. These are the most vulnerable. The recording of the *Phragmites australis* (CAV.) TRIN. EX STEUD. on the top of a mound reed means that the groundwater level, which keeps the growth and development of this hydrophilic species, is not at a very large depth.

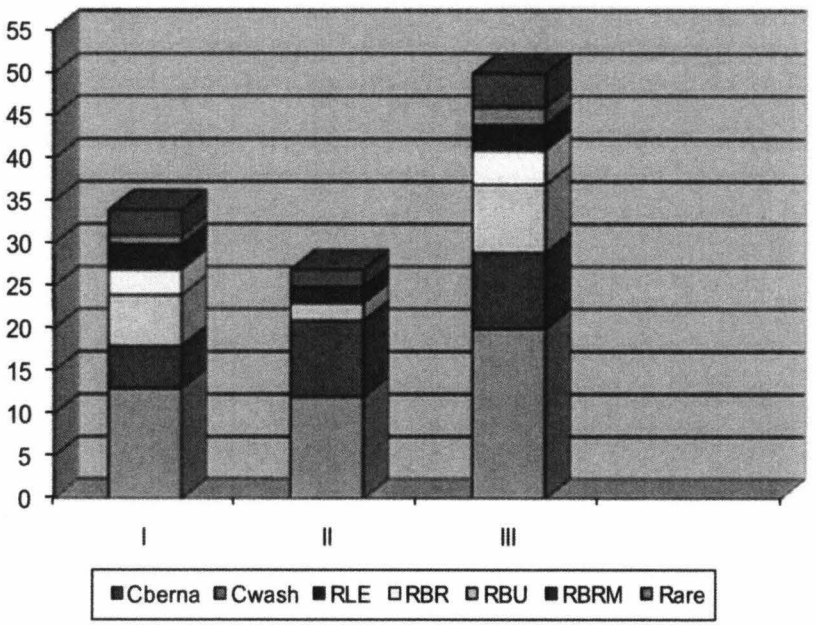


Figure 2. Valuable species of flora and fauna from the investigated objects. I - LR Suta de Movile, II - GPNM Duruitoarea Gorge, III - NFR Şaptebani. / Figura 2. Specii valoroase din obiectivele investigate. I - RP Suta de Movile, II - MNGP Defileul Duruitoarea, III - RNS Şaptebani.

The topography and hydro-thermal regime peculiarities of the LR Suta de Movile, creates special conditions for different groups of fauna. Lake areas are preferred by amphibians and reptiles, and the slopes - by mammals. Among mammals species there have been recorded *Vulpes vulpes* (LINNAEUS 1758), protected by Washington Convention, listed in Annex III and RLE; including such reptiles as - *Lacerta viridis* (LAURENTI 1768), listed in Annex II of Bern Convention, RLE and RBU. Among the representatives of amphibians, there were registered - *Hyla arborea* (LINNAEUS 1758), listed in Annex II of Bern Convention, RLR and RLE and among insects - *Scolia maculata* (DRURY 1973), *Manduca atropa* (LINNAEUS 1758), *Mantis religiosa* (LINNAEUS 1758) - included in Red Book of the Republic of Moldova (RBRM) and *Satanas gigans* (EVERSMANN 1855), *Saturnia pyri* (DENIS et SCHIFFERMUELLER 1775) - included in RBRM and RBU.

In order to conserve the natural heritage and the landscape of this reserve, it is necessary to observe strictly the status of LR as provided by law, and landscape reconstruction requires for stopping of farming so that to ensure the restoration of flora and fauna composition gradually in the future.

GPNM Duruitoarea Gorge, with an area of 40 hectares, is located on the left bank of the Ciuhur River, a tributary of the Prut River, east from Duruitoarea village, Rîşcani district. Official landowner of the reserve is Duruitoarea village hall. In the North direction of the Gorge, on a length of about 1 km, it lays a Badenian limestone cliff, with a height of over 10 m. A series of caves extends on an area of 135 m^2, which have a horizontal bottom (abrasive traces and deforming activities). In the gorge, over a length of 130 m, limestone toltrels can be found (ŢARIGRADSCHI, 2003).

Local human impact is insignificant. Although there have not been identified organic spills or landfills, sometimes in the vicinity of the village, there are areas with several unauthorized waste dumps and in some areas extraction of stone is done. Within the gorge there have been registered steppe areas used for animals grazing, which could disturb the ecological balance of this picturesque landscape. The content of heavy metals in the shells of molluscs - *Helix pomatia* (LINNAEUS 1758) and *Cepaea vindobonensis* (FERRUSSAC 1821) attests concentrations that do not exceed allowable levels, which indicated for lack of pollution.

Duruitoarea Gorge presents a rich landscape with special geological features through the monumental grandeur of the rocks, with high waterfalls that flow, and increase in spring and summer as a result of torrential rains. In addition, Duruitoarea gorge is a real deposit of flora and fauna, particularly of petrophyte and steppe species.

Among the higher plants there have been recorded valuable species included in RBRM (Fig. 2): *Schivereckia podolica* (BESS.) ANDRZ. EX D. C., *Rhamnus tinctoria* WALDST. et KIT., *Sempervivum ruthenicum* SCHNITTSP. et C. B. LEHM. all with the status of vulnerable species, *Vitis sylvestris* GMEL. - the status of endangered species and *Gypsophila glomerata* PALL. ex ADAMS- critically endangered species. *Gypsophila glomerata* PALL. ex ADAMS has international protection status and it is included in RBU and RLE. Along the listed species there were recorded species which are also rare in the flora of the Republic of Moldova. On the surface rocks, sparsely covered with a layer of soil, there grow rich clusters of *Aurinia saxatilis* (L.) DESV. and among the shadowy cracks of rocks - *Asplenium ruta-muraria* L. and rare species of - *Homalothecium philippeanum* (SPRUCE) B.S.G. The sectors rich in soil are populated by *Clematis*

vitalba L., *Cotoneaster melanocarpus* FISH. EX BLYTT, *Vinca minor* L. and in sectors near the Duruitoarea River - *Acorus calamus* L.

The geological and hydrological elements as well as specific vegetation create favourable conditions for many common animal species, which are taken under protection. Among them, particular values have the endangered insect species included in RBRM: *Mantis religiosa* (LINNAEUS 1758), *Morimus funereus* (MULSANT 1873), *Oryctes nasicornis* (LINNAEUS 1758) and vulnerable species - *Papilio machaon* (LINNAEUS 1758). Some species, ordinary for the Republic of Moldova, are among those with international status, being found in the Annexes of Environmental Conventions. Such species are the *Lacerta viridis* (LAURENTI 1768), included in Annex II of the Bern Convention, RBU, RBE and *Helix pomatia* (LINNAEUS 1758), listed in Annex III of the Bern Convention (1979). The Duruitoarea River, which crosses the gorge and the small waterfalls which are formed in some places, create a habitat for growth and development of rich diversity of plant and animal species. The water and the river bank serve as habitat for some species of aquatic and marsh plants and animals. Algae research from the Duruitoarea River has revealed the following diversity of the algal species, which are common as well for adjacent ecosystems: communities of *Chaetomorphetum - Diatomocearum* (*Cocconeis pediculus* EHR. FURTNER.); there have been detected some species, which also common for adjacent basins: *Scenedesmus opoliensis* P. RICHTER, *S. quadricauda* (TURP) BREBISSON, *Chlamydomonas* EHR., *Pediastrum duplex* MEYEN, *Tetraedron minimum* REINSH, *Gongrosira debaryana* RABENH., *Campylodiscus noricus* HER., *Gyrosigma stagnalis* (KUTZ.) RABENH., *Oscillatoria brevis* (KUTZ.) GOM. There were recorded also some valuable species of red algae: *Thorea ramosissima* BORY, *Batrachospermum moniliforme* ROTH and *Lemanea* sp., blue algae: *Johanesbaptistia gardner* FREMY and *Gomontiella subtubulosa* TEODORESCO and green algae: *Draparnaldia plumosa* (VAUCHER) AGARDH.

It is necessary to note the absence in this habitat of euglenophyte. The presence of the bivalve genus *Anodonta*, indicators of relatively clean water, let us suppose that the water of the Duruitoarea River is characterized by a low content of organic pollutants. Confirmation of water quality has been achieved also by chemical analysis. Thus, the water of the Duruitoarea River corresponds to class II for surface water quality and the small river, which passes through the gorge Duruitoarea, need to be protected together with other components of the gorge. The Duruitoarea gorge is important not only due to the presence of geological and paleontological elements (according to Law no. 1538-XIII), but also due to the presence of valuable habitats for flora and fauna and the presence of water source as well. The presented arguments demonstrate convincingly the need to protect the scenic landscape in the complex as a whole and suggest the need to change the current status of protection of the Duruitoarea gorge from GPNM into a status that provides for protection of landscape as a whole, and to be given the category - Mix Nature Monument, which in accordance to the Law on State Protected Natural Areas Fund includes valuable items of botanical, zoological, geological and hydrological origin.

NFR Şaptebani with a surface of 17 ha is located in Rîşcani Forestry Detour. According to forest arrangements only the parcel 60 D of the forest near the Şaptebani village is protected. The value of this sector was assessed based on the arboreal vegetation, which consists of lime trees (90%), mixed with oak (10%), the density of which is 0.63 (for lime) and 0.07 (for oak) on a unity of surface, characterized by a normal vitality, tree height is 20 and 19 m and the average age is 55 years.

Along with the protected area, the phytocenological study included as well the north-western part of the forest (sub parcels 59A, 59B, 59C, 59D, and partially 60A, 61A, 61B, 61C, 61D) with a great floral diversity. The grassy carpet is well developed, composed of common species, including many species of valuable plants which are protected both nationally and internationally (Fig. 2): *Doronicum hungaricum* REICHENB. fil.– a vulnerable species, included in RBRM and RBU, *Lilium martagon* L., *Tulipa bibersteiniana* SCHULT. et SCHULT. fil., *Veratrum nigrum* L., which besides being rarely encountered within the country, have international protection status: *Tulipa biebersteiniana* is included in RBU, *Veratrum nigrum* - RLR and *Lilium martagon* – RBU and RLE. In sub parcels 59A, 59B, 59C there were found *Asplenium trichomanes* L. and *Cystopteris fragilis* (L.) BERNH, *Asplenium ruta-muraria* L., which is part of the list of rare plants, protected by the state. The "pearl" of these particular sector is the *Hepatica nobilis* MILL., vulnerable species, comprising about 10 specimens per m^2, particularly in the areas around limestone rocks. Slightly less common is *Fritillaria meleagroides* PATRIN EX SCHULT et SCHULT FIL. Both species are vulnerable and included in the RBRM and RBU. Their protection requires the extension of the existing protected areas, including the listed sub parcels. In addition to higher plants there have been recorded species of lichens and mosses, which can serve as indicators of air pollution from ecosystems and are also rare species with different protection status. Thus, the forest serves as habitat for various species of lichens, including the species *Dermatocarpon miniatum* (L.) MANN. found in RBRM, *Pseudoparmelia quercina* (WILLD) VAIN., *Opegrapha rufescens* PERS., *Parmelia cetrarioides* DEL. - rare species, *Parmelia sulcata* TAYL., which is a veritable indicator of air quality (BEGU 2011). Calcareous substrates serve as good base for petrophyte lichen species as *Placolecanora muralis* (SCGREB.) RAS., *Caloplaca murorum* (HOFFM.) TH. FR., *Candelariella vitellina* (EHRH.) MULL. ARG., which have a low frequency throughout the country. Some moss species were recorded: i.e. *Anomodon viticulosus* HOOK et TAYL., *Leskea polycarpa* HEDW., *Homalothecium philippeanum* (SPRICE) SCHIP., *Atrichum undulatum* (HEDW.) P. BEAUV. - sensitive to air pollution and *Climacium dendroides* (HEDW.) WEB., endangered species, included in the Red Book of the Republic of Moldova, previously indicated by SIMONOV, 1978 only in 3 stations in Edineţ, Orhei and Ungheni rayons.

Among representatives of mollusc species *Cepaea vindobonensis* (FERUSSAC 1821) and *Helix pomatia* (LINNAEUS 1758) deserves attention; they prefer calcareous soils and have been recorded in abundance. These species best accumulated heavy metals, especially, *Helix pomatia*, which is recommended for use in performing monitoring of the soil content in *Cd, Cu* and pesticide pollution. Among mammals it was recorded *Felis silvestris* (SCHREBER 1777), protected both nationally and internationally: included in RBRM as endangered species and listed in Annex II of Bern Convention, and Annex II of CITES Convention, RLE, RBR, RBU. Among the valuable species of reptiles there have been recorded *Coronella austriaca* (LAURENTI 1768) and *Lacerta viridis* (LINNAEUS 1758). *Coronella austriaca* is protected nationally and thus included in RBRM as endangered species, while internationally it is included in the Appendix II of Bern Convention. The same protection status has *Lacerta viridis*. Among insects, there were registered: *Oryctes nasicornis* (LINNAEUS 1758) and *Morimus funereus* (MULSANT 1873) - endangered species included in RBRM.

The vegetation of the steppe sector, along with herbaceous vegetation, includes *Amygdalus nana* L. – a plant protected by state and listed as vulnerable. An increased abundance is characteristic for ephemeroides, especially *Adonis vernalis* L., species vulnerable at national level and included in Appendix II of CITES Convention, Washington, (1979) and RBU. This species is dominant in open areas and is the main attractive element of these places, with coverage of about 70-80%. The limestone hills, bordering the forest, especially in spring, are dominated by *Pulsatilla montana* (HOPPE) REICHEINB.- rare species, protected both in our country and in Romania, being included and RBR.

The studied forest sector is crossed by the Ciuhureț River, along which it lies a chain of steep cliffs, which amaze by the richness of flora and fauna. Vegetation analysis showed the predominance in the river water of algae populations - green algae: *Cladophoretum* (*C. glomerata* SAUER 1937; *C. fracta* O. F. MULL. EX VAHL.), *Rhizoclonietum* (*Rh. hieroglyphycum*), *Draparnaldietum (D. glomerata* (VAUCH.) C. AGARDH, *D. plumosa* (VAUCH.) C. AGARDH), characteristic of clean water and a series of rarer species, such as rhodophyta - *Thorea ramosissima* BORY, *Batrachospermum moniliforme* ROTH; chrysophyta: *Hydrurus foetidus* (VILL.) TREV., cyanophytes - *Oscillatoria agardhii* GOM., *Gomontiella subtubulosa* TEODORESCO and *Johanesbaptistia gardner* FREMY, which strengthens the scientific value of the given object. The water quality of the Ciuhureț River was confirmed by laboratory evidence, which places it in the Class II of surface water quality.

The list of species of plants and animals mentioned in this study serves as a basis to complete the register of flora and fauna of the areas investigated and scientifically support the need to allocate special protection measures for parcels 59A, 59B, 59C, 59D, 60A, 61A, 61B, 61C, 61D, together with the parcel 60D (already protected). Including areas rich in valuable plants and animal species, geological and hydrological representative objects and in accordance with the Chapter 4, Art. 37, point "e" of the Law on State Protected Natural Areas Fund, the mentioned areas need to be given the status of Mix Nature Monument (MNM): and specifically MNM name "Adonis" (*Adonis vernalis* – being a dominant species, which present an attractive element of the area).

CONCLUSIONS

1. The investigated objects are valuable landscapes characterized by a good ecological status of the main environmental components (soil, water, air, biota) and serve as preferred habitats for rare flora and fauna species, protected nationally and internationally.

2. The geological and hydrological elements contributed to the formation of the original landscape and creation of specific habitats for steppe, petrophyte and aquatic plant and animal species.

3. The results of heavy metal content in soil and mollusc shells (*Helix pomatia* and *Cepaea vindobonensis*) attest that, these do not exceed allowable levels; the water quality in main streams and those parts that cross the forest near the gorge Duruitoarea and Şaptebani village corresponds to class II of quality of surface waters; air pollution from local and transboundary sources is insignificant, which confirms the absence of significant pollution of the research objects.

4. The research results serve as a scientific argument concerning the need to protect the landscape as a whole, integrally together with its geological, hydrological, flora and fauna species elements, which will also ensure the implementation of the Rio Convention (1992) provisions on the country need to encompass protected areas with different category.

REFERENCES

BEGU A. 2011. *Ecobioindicația: premise și aplicare*. Edit. Noosfera. Academia de Științe a Moldovei. Chișinău. 166 pp.

BEGU A., MANIC Ș., ȘALARU V., SIMONOV GH. 2005. *Lumea vegetală a Moldovei. Ciuperci, plante fără flori*. Edit. Știința. Chișinău. **1**. 204 pp.

BOBOC N. & MELNICIUC O. 2006. *Resursele de apă. Resurse naturale*. Seria Mediul geografic al Republicii Moldova. V. I. Î.E.P. Edit. Știința. Ministerul Ecologiei și Resurselor Naturale. Chișinău: 80-105.

CONSTANTINOV T., COȘCODAN M., BOIAN I., NEDEALCOV M. 2006. *Resursele climatice. Resurse naturale*. Seria Mediul geografic al Republicii Moldova. V. I. Î.E.P. Edit. Știința, Ministerul Ecologiei și Resurselor Naturale. Chișinău: 60-73.

GHEIDEMAN T. S. 1975. *Opredeliteli vâssih rastenii Moldavscoi SSR*. Edit. Știința. Chișinău. 636 pp. [In Russian].

GROSSU AL. V. 1986. *Gastropoda României.* Edit. Litera. Bucureşti. **5**(1): 103-117.

IVAN D. & DONIŢĂ N. 1975. *Metode practice pentru studiul ecologic şi geografic al vegetaţiei.* Centrul de multiplicare a Universităţii din Bucureşti. 47 pp.

LEVADNIUC A. T. 1978. *Relief.* Atlas Moldavscoi SSR. ANMSSR. Moscva: 29-37. [In Russian].

MUNTEANU A. & LOZAN M. 2004. *Mamifere.* Lumea animală a Moldovei. Edit. Ştiinţa. Chişinău. **4**. 132 pp.

NEGRU A., ŞABANOV G., CANTEMIR V. 2002. *Plante rare din flora spontană Republicii Moldova.* Edit. Ştiinţa. Chişinău. 198 pp.

OBUHOV A. I. & ZÂRIN N. G. 1977. *Spectralinâi analiz pociv, rastenii.* Moscva. 334 pp. [In Russian].

POSTOLACHE GH., CĂLDĂRUŞ V., TELEUŢĂ A. 2004. *Paşaportul ariei protejate.* Mediul Ambiant. Edit. Mediul Ambiant. Chişinău. **5**(16): 18-20.

PROCA B. E. 1978. *Landşaftî.* Atlas Moldavscoi SSR. ANMSSR. Moscva: 69-77. [In Russian].

SIMONOV GH. 1978. *Opredeliteli listostebelinâh mxov Moldavscoi SSR.* Edit. Ştiinţa. Chişinău. 167 pp. [In Russian].

ŢARIGRADSHI V. 2003. *Ghidul ecologic al Prutului de Mijloc.* Colecţia Natura. Chişinău. 10 pp.

URSU A. 2006. *Raioanele pedogeografice şi particularităţile regionale de utilizare şi protejare a solurilor.* Societatea Naţională a Moldovei de Ştiinţa Solului. Chişinău. 232 pp.

***. *Cartea Roşie a Republicii Moldova.* 2001. Ediţia a doua. Ştiinţa. Chişinău. 288 pp.

***. *Cartea Roşie a vertebratelor din România.* 2005. Muzeul Naţional de Istorie Naturală „Gr. Antipa". Bucureşti. 260 pp.

***. *Cheklist of CITES species and Annotated CITES appendices and Reservations.* 1979. Washington. 417 pp.

***. *Convenţia privind Conservarea speciilor migratoare de animale sălbatice.* Bonn. 1979.

***. *Convention on the Conservation of European Wildlife and Natural Habitats.* Berm. 1979.

***. *Legea privind fondul ariilor naturale protejate de stat.* Chişinău. 2002.

***. *Lista Roşie a plantelor superioare din România.* 1994.

***. *Lumea animală.* Cartea Roşie a Ucrainei. 2009. Maister-print. Kiev. 608 pp.

***. *Lumea vegetală.* Cartea Roşie a Ucrainei. 2009. Globalconsalting. Kiev. 912 pp.

***. *Metodica rasciota conţentraţii v atmosfernom vozduhe vrednâh veşcestv, soderjaşcihsea v vâbrosah predpriatii.* OND-86, 1987. Gidrometizdat. Leningrad. 60 pp. [In Russian].

***. *Metodica vipolnenia izmerenii massovoi doli metallov i oxidov metallov v poroscovih probah pociv metodom rentghenofluorescentnogo analiza.* (M-049-П/02) ООО НПО „SPECTRON". 2002. S-Peterburg: 16 pp. [In Russian].

***. NORCAS-02. *Normativul privind obiectele de referinţă pentru clasificarea calităţii apelor de suprafaţă.* MO. Nr. 197/27 martie 2003. Bucureşti.

***. *Proceedings of the training workshop on critical loads calculations for air pollutants and mapping in east and south-east Europe.* 2001. UNECE Convention on long-range transboundary air pollution. Chişinău. 144 pp.

***. *Transboundary Acidifying Air Pollution in Europe, EMEP, Co-operative programme for monitoring and evaluation of the long range transmission of Air pollutants in Europe.* MSC-W Status Report 1998. Part 2: Numerical Agendum.

***. *UICN Red List Categories.* 1994.

Liogchii Nina, Begu Adam, Brega Vladimir, Donica Ala
Institute of Ecology and Geography, Chişinău,
Str. Academiei, No. 1, MD 2028, Republic of Moldova
E-mail: ninaliogchii@mail.ru

Received: March 31, 2011
Accepted: August 27, 2011

GROUNDWATER FLUCTUATION OF THE BALTIC COAST IN THE SLOWINSKI NATIONAL PARK AND ITS EFFECT TO LOCAL DIVERSITY

CZERNIAWSKA Jolanta

Abstract. The Slowinski National Park is one of the two coastal national parks in Poland. It is situated in the central Polish Baltic coast. The natural values of the Park are determined by the different ecosystems that operate in conjunction with surface waters and ground waters. The water surface area reaches 47.4% in the Park. The largest area is occupied by Gardno and Łebsko lakes. Around the lakes it is possible to follow the model belt arrangement of vegetation: from typically water biotopes, through marshy and waterlogged ones to typically land ones. This paper presents the preliminary results of the studies on shallow groundwater fluctuation and their implications for the environment, particularly for biodiversity. The shallow groundwater level monitoring data were collected in Łeba Barrier area in northern part of the Slowiński National Park. The piezometers were situated between the Baltic Sea and Łebsko Lake. Groundwater monitoring was conducted in the area of the coastal dunes, in the pine forest zone and on the marshy area, which extends in the vicinity of Łebsko Lake.

Keywords: groundwater fluctuations, Baltic coast, biodiversity.

Rezumat. Fluctuaţiile apei freatice de pe coasta baltică a Parcului Naţional Slowinski şi efectele sale asupra diversităţii locale. Parcul Naţional Slowinski este unul dintre cele două parcuri naţionale principale din zona de coastă a Poloniei. Este situat în partea centrală a coastei baltice poloneze. Valorile naturale ale parcului sunt determinate de diferitele ecosisteme legate de apele de suprafaţă şi subterane. Apele de suprafaţă acoperă 47,4% din suprafaţa parcului. Cea mai mare suprafaţă revine lacurilor Gardno şi Łebsko. În jurul acestora, vegetaţia se dezvoltă sub formă de centuri: de la biotopurile tipic acvatice, la cele caracteristice mlaştinilor şi zonelor cu exces de umiditate, urmate apoi de cele tipic terestre. Lucrarea prezintă rezultatele preliminare ale studiilor privind fluctuaţiile pânzei freatice şi implicaţiile acestora asupra mediului, în special asupra biodiversităţii. Monitorizarea pânzei freatice a fost făcută în zona barierei Łeba, în partea de nord a Parcului Naţional Slowiński. Piezometrele au fost amplasate între Marea Baltică şi Lacul Łebsko. Monitorizarea apei freatice s-a făcut în zona cu dune costale, în pădurea de pini şi în arealul mlăştinos care se extinde în vecinătatea Lacului Łebsko.

Cuvinte cheie: fluctuaţiile apei freatice, coasta baltică, biodiversitate.

INTRODUCTION

Water ecosystems: rivers, lakes, marshlands and wetlands constitute an essential element of the landscape in the majority of the national parks and are habitats for valuable plant associations and fauna concentrations. Adverse changes in the level of groundwater are one of the greatest threats to the protected biotic environment. This applies both to the excessive rise in water table and excessive lowering of water levels, which leads to dry land.

The Slowinski National Park is one of the two coastal national parks in Poland. It is situated in the central part of the Polish Baltic coast. The Slowinski National Park is the northern part of the Lowland Gardnieńsko-Leba, which was formed after the last glaciation (ROTNICKI, 2008). At the beginning of the Holocene, the lowland occupied a spilway of the Reda-Leba, which was the area of the Baltic transgression later (ROTNICKI, 2009). The transgressions affect the swamps and bioaccumulation processes. In the past, the groundwater level was much higher and the plain was covered with swamps. At the end of the eighteenth century, the anthropogenic drainage was initiated in the lowlands and the canals were built. This process has triggered a significant reduction in water levels (SZALEWSKA, 2003) and changes in vegetation. The original natural peat bogs have been converted into meadows.

On this small part of the Baltic Coast the sea, lakes, rivers, dunes, forests, peat bogs and meadows border on each other to form a diversified mosaic of environments and thus also of microclimates and biocoenoses. Around the lakes it is possible to follow the model belt arrangement of vegetation: from typically water biotopes, through marshy and waterlogged ones to typically land ones. This reflects not only the effect of change in water conditions on the structure of plant communities but also the stages in the turning of water regions into land. The composition of ecosystems and the absence of human interference in the processes many of which are subject to, makes the whole a very interesting, living natural museum. In 1977, the park was recognized by UNESCO as a World Biosphere Reserve. Due to the presence of particular importance of wetlands the park was included in the list of Ramsar Convention in 1995.

In the Slowinski National Park, the water surface area covers 47.4%. The largest area is occupied by lakes: Gardno Lake and Łebsko Lake arose as a result of sand bars gradually cutting off the former lagoons (ROTNICKI, 2009). It is the largest coastal lake and the third largest lake in Poland. Its total area is 7 020 ha. Its depth only at some sites reaches 4-6 m. Łeba Barrier separates the lake from the Baltic Sea. The groundwater of the spit is in contact with the waters of the lake and the Baltic Sea.

The article presents the nature of the changes of the groundwater level in Leba Barrier, which are particularly important for the functioning of ecosystems found there (Figs. 2; 3; 4).

MATERIAL AND METHODS

Groundwater is found in the study area in permeable sediments of fluvio-glacial, marine and river origin. Groundwater level is usually at a depth of 1 to 5 m, and in Leba Barrier even below 15 meters (LIDZBARSKI, 2004). An important element in the protection of ecosystems and groundwater, its existing and potential threats is the monitoring. The continuous systematic observations of the groundwater level started under the project on groundwater dynamics in August 2008. The shallow groundwater level monitoring data were collected in the Łeba Barrier area in northern part of the Slowiński National Park. The piezometers were positioned between the Baltic Sea and Łebsko Lake (Fig. 1). Groundwater monitoring was conducted in the area of the coastal dunes, in the pine forest zone and on the marshy area, which extends in the vicinity of Łebsko Lake (Figs. 1; 2; 3). The electronic recorders - DIVER (Schlumberger Water Service) were installed in the piezometers and in Łebsko Lake. The water level and temperature were measured every two hours. The measurements of sea level on the Polish coast, rainfall and air temperature were conducted by the Institute of Meteorology and Water Management.

RESULTS AND DISCUSSIONS

This summarizing article presents the results of observation of water levels by six piezometers located in the belt of coastal dunes (piezometers: B-1 and B-2), in the pine forest belt (B-3 and B-4) and in the marshy belt (B-7 and B-8). One piezometer B-4 (6.3 m asl) is located higher above the sea level in places, where groundwater is flowing in two directions: into the sea and the lake. The piezometers closest to the sea are located at heights of 2.0 m asl (B-2) and 1.7 m asl (B-1). The lowest are the piezometers in the marshy area: 0.04 m asl (B-8) and 0.5 m asl (B-7). The average depth to groundwater, calculated for the period October 2008 - September 2010 is varied in each piezometer. The shallowest groundwater occurs in the marsh area. In the piezometer B-8, the average depth was 16 cm and the groundwater were about 16 cm under the sea level. In the piezometer B-7 the average depth of groundwater is 20 cm. Shallow water level in this zone is related to the impact waters of Lake Łebsko and outflows of groundwater from the dunes of the spit. The lowest level of groundwater was located in the pine forest zone, as the piezometer B-4 indicated a depth of 95 cm. Relatively low depth of groundwater in the entire period of study was also observed in the area of the coastal dunes in piezometer B-1 - 86 cm. This was mainly caused by marine conditions of the Baltic Sea. The average level was 504 cm in the Baltic Sea, with the maximum water level 604 cm during a storm in October 2009. Storm Surges ($H \geq 570$ cm) along the central coast during the analysis period occurred very rarely. The largest fluctuation occurred in the groundwater piezometer B-8, located near Lebsko Lake. The difference between the highest and lowest water levels reached 111 cm. Groundwater is in contact with the waters of the lake. The large fluctuations in groundwater levels are related to the dynamics of surface waters of the lake. Its hydrological regime is conditioned on one hand by the inflow of water from rivers, alimenting it on level 80-90%, on the other hand by changing hydrodynamic conditions between the lake and the Baltic Sea (CHLOST & CIEŚLIŃSKI, 2005). The present lake water level is often below sea level. The lowest lake water levels reached 55 cm below the sea level. Łebsko Lake is connected to the Baltic Sea and its water is brackish (CZERNIAWSKA & SPYCHALSKI, 2010). The data showed that the sea level changes had a direct and very fast effect on the level and salinity of the Lebsko Lake. This was particularly evident during the storm in September 2009 (CZERNIAWSKA, 2011). In addition, the lake occupies a large area and is shallow and represents a unique natural ecosystem. The lake surface reflects the impact of wind on water dynamics. The average water level of Łebsko Lake was 11 cm asl. and was higher than the average water level in the piezometer B-8. A drop in water level is observed in winter months when the lake level is lower than the groundwater (piezometer B-8). On this basis, it can be concluded that throughout the year, groundwater is being supplied by lake waters. Brackish waters of Łebsko Lake are important for functioning of the protected halophytic plant communities that occur in the vicinity of the southern part of the lake. In other research locations, fluctuation of groundwater ranged from 65 cm (B-7) to 98 cm (B-3).

Periods of the minimum and maximum water levels throughout the year can be observed on the basis of the calculated average monthly groundwater fluctuation data. The performed analysis shows that fluctuations of the groundwater conditions of Leba Barrier are not synchronous. This clearly shows the results for 2009 and 2010. In the area of the dune distribution, the minimum groundwater level occurred in May 2009. In the pine forest belt, the minimum conditions of groundwater were observed in June 2009. The lowest water level in the marshy area (piezometer B-8) also occurred in May 2009 and until August 2009 (piezometer B-7). The maximum values of the groundwater levels in the forest area occurred in March 2009 and in the zone of dunes and marshy area in October 2009. The increase in groundwater level in spring was caused by snow melting and by a storm in the Baltic Sea in fall (October), causing also an increase in water levels of Lake Łebsko. Different dynamics of groundwater levels were observed in 2010. The minimum conditions of groundwater occurred in the belt of sand dunes and the forest area in February. A reduction of water was caused by very low temperatures, which lasted since January and caused ground freezing. The average temperature for January 2010 was -5.5°C (minimum -18.4°C) and -1°C in February. In the marshy area, the lowest groundwater levels were observed only in July and were due to very high temperatures (average temperature of +19.9°C, and maximum temperatures > +30°C). The impact of high air temperatures in July 2010 was marked by a clear ground water reduction as observed in all piezometers. The highest water levels that year occurred in

March at the belt of marshland and in other areas until September after a significant rainfall. In September 2010, a total of 152.1 mm of rain fell in the study area, representing the most intensive rainfall during the whole observation period. The research results indicate the need for follow-up of groundwater fluctuations.

The resulting data show large variations of groundwater fluctuations in time and space along the central Polish Baltic coast. Extreme events like storms on the Baltic Sea, very high and low temperature as well as heavy rainfalls, all have major impacts on the dynamics of groundwater. Occurrence of these phenomena makes it difficult to identify closed-system trends and changes in the groundwater conditions in the coastal zone of the Slowinski National Park. Rapid increases in high summer temperatures are a threat to the pristine natural swamp belt, where they can cause degradation of the wetland ecosystems. High sea levels directly affect the ingression of saline water into surface waters and groundwater. Studies of groundwater chemistry have shown that the most vulnerable to the encroachment of saline wetlands are the places located in the vicinity of Łebsko Lake (CZERNIAWSKA & SPYCHALSKI, 2011). An exceedingly high level of groundwater poses a serious threat to local pine forests. The continuing high groundwater level in the second half of 2010 initiated a slow degradation of the stand of Leba Barrier. This has also negative effects on Klucki Forest reserve and its natural biotopes (CHRZANOWSKI & KLUCZYŃSKI, 2004).

CONCLUSIONS

This summary paper presents the results of the systematic pilot studies on a shallow groundwater fluctuation and sea-coastline geo- and ecosystem dynamics and its implications for environment, including local biodiversity. The research implications are of major relevance for the protection and environmental management of the Slowinski National Park. A long-term groundwater monitoring is particularly essential to biodiversity, especially for observations of changes in vegetation cover. For future ecology studies based on a multidisciplinary approach, it is necessary to determine the scale, scope and frequency of potential risks of groundwater fluctuations to local ecosystems, particularly to plant species and their communities established on sand dunes, and in the coastal pine and mixed forests as well as the peat bog / marshland biotopes. The collected data should be used for the modelling of seasonal groundwater changes and forecasting of environmental shifts in the Slowinski National Park. It should be stressed that changes in the coastal groundwater hydrogeological conditions are closely inter-linked to other environmental changes in the Polish Baltic coastal zone with the observed accelerating rate of effects to the progressing coastal erosion (DZIADZIUSZKO & JEDNORAŁ, 1987; ROTNICKI & BORZYSZKOWSKA, 1999). These natural processes are presumably associated with global climate change and the corresponding ocean / Baltic Sea levels rise (ROTNICKI et al., 1995).

ACKNOWLEDGEMENTS

Scientific work financed from funds for science in the years 2007-2009 as a research project.

REFERENCES

CHLOST I. & CIEŚLIŃSKI R. 2005. *Change of level of waters Lake Łebsko.* Limnological Review. Publisher Versita Open. Polish. **5**: 17-26.

CZERNIAWSKA J. 2011. *Fluctuation of shallow groundwater level of the Leba-Gardno Coastal Plan, Polish coast.* Conference Proccedings, The 8th Baltic Sea Science Congress. Abstract. St. Petersburg: 13.

CZERNIAWSKA J. & SPYCHALSKI W. 2010. *Chemical properties of Łebsko and Dołgie Wielkie Lakes waters.* Mineralogia, Special Papers. Krakow. **36**: 24-28.

CZERNIAWSKA J. & SPYCHALSKI W. 2011. *Uwarunkowania chemizmu pierwszego poziomu wód podziemnych na obszarze Mierzei Łebskiej.* Conference Proccedengs. XX Sympozjum Zintegrowanego Monitoringu Środowiska Przyrodniczego. Abstrakt: 20-25.

CHRZANOWSKI T. & KLUCZYŃSKI B. 2004. *Przewodnik „Klucki Las".* Smołdzino. Słowińskim Parku Narodowym: 12.

DZIADZIUSZKO Z. & JEDNORAŁ T. 1987. *Wahania poziomu morza na polskim wybrzeżu Bałtyku.* Studia i Materiały Oceanologiczne. Sopot. **52**: 215-238.

LIDZBARSKI M. 2004. *Plan Ochrony Słowińskiego Parku Narodowego. Operat ochrony zasobów i walorów przyrody nieożywionej i gleb.* Tom III. Operat Hydrogeologiczny. Jeleniogórskie Biuro Planowania i Projektowania. Slupsk: 20-25.

ROTNICKI K., BORÓWKA R. K., DEVIN N. 1995. *Accelerated Sea –Level Rise as a Threat to the Polish Coastal Zone – Quantification of risk.* In: Rotnicki (Ed.) Polish Coast – Past, Present and Future. Journal of Coastal Research. Spec. Issue. **22**: 111-135.

ROTNICKI K. & BORZYSZKOWSKA W. 1999. *Przyspieszony wzrost poziomu morza i jego składowe na polskim wybrzeżu Bałtyku w latach 1951 – 1990.* In: Borówka, Młynarczyk, Wojciechowski (Eds.) Ewolucja geosystemów nadmorskich południowego Bałtyku: 141-160.

ROTNICKI K. 2008. *Problem wieku najstarszego Bałtyku holoceńskiego na polskim wybrzeżu środkowym.* In: Rotnicki, Jasiewicz, Woszczyk, (Eds.) Holoceńskie przemiany wybrzeży i wód południowego Bałtyku – przyczyny, uwarunkowania i skutki: 103-111.

ROTNICKI K. 2009. *Identyfication, age and causes of the Holocene ingressions and regressions of the Baltic on the Polish Middle Coast*. Kornik. Polish. **6**: 1-100.

SZALEWSKA E. 2003. *Zagospodarowanie przestrzenne, krajobraz kulturowy i architektura budowli otoczenia Jeziora Gardno*. In: Mudry (Ed.) Jezioro Gardno: 155-191.

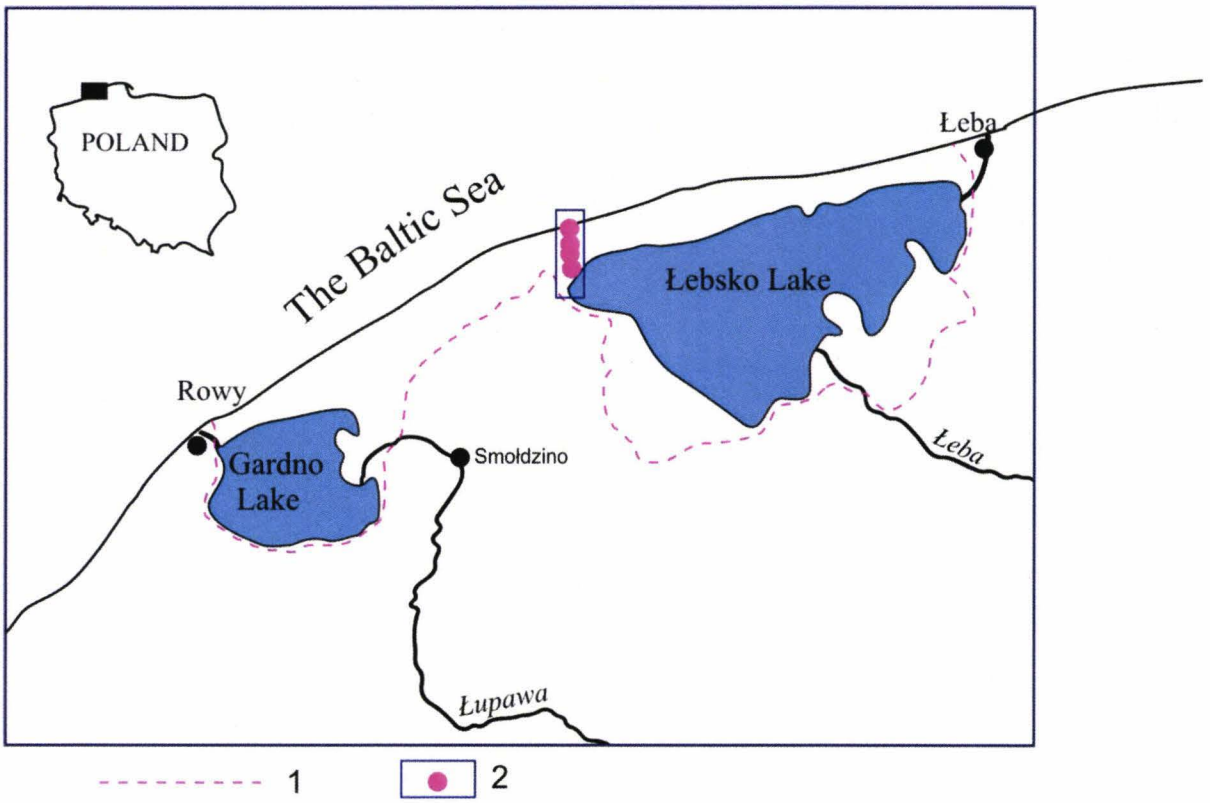


Figure 1. Location of the study area and piezometers. 1 – border of the Slowinski National Park; 2 - study area (the piezometer transect).
Figura 1. Localizarea zonei de studiu şi a piezometrelor. 1 – limita Parcului Național Slowinski: 2 – zona de studiu (linie piezometrică) (original).

Figure 2. The belt of coastal sand dunes in the Slowinski National Park (with *Carex arenaria*). A piezometer location.
Figura 2. Dune de nisip în zona de coastă a Parcului Național Slowinski (cu *Carex arenaria*). Localizarea piezometrelor (original).

Figure 3. The peat bogs occupy the shore areas of the Lebsko Lake, the Slowinski National Park.
Figura 3. Turbăriile ocupă arealele de pe ţărmurile lacului Lebsko, Parcul Naţional Slowinski (original).

Figure 4. The alder carr (*Carici elongatae-Alnetum*) which develops along the shore of Lebsko Lake, The Slowinski, National Park.
Figura 4. *Carici elongatae-Alnetum* care se dezvoltă de-a lungul ţărmurilor Lacului Lebsko, Parcul Naţional Slowinski (original).

Czerniawska Jolanta
Institute of Geoecology and Geoinformation,
Adam Mickiewicz University,
Dziegielowa Str. 27, 61-680 Poznań, Poland
E-mail: jolczer@amu.edu.pl

Received: March 26, 2011
Accepted: August 8, 2011

NEW CONTRIBUTIONS TO THE CIOCADIA MIDDLE MIOCENE FLORA (PART ONE)

PARASCHIV Valentin, SEBE Oana-Gabriela

Abstract. The present paper re-evaluates the record of Middle Miocene (Late Badenian-Early Sarmatian) plant megafossils in the Ciocadia area (North of Oltenia Province) according to current taxonomy, and describe new fossil plant remains. Some previous taxa determinations have been found incorrect or updated. At the same time, we provide new diagnosis for some misinterpreted taxa (*Sphaerites*, *Platanus*) and in the case of just signalled or figured taxa (*Cystoseirites*, *Tetraclinis*, *Cunninghamia*, *Glyptostrobus*, *Picea*).

Keywords: plant fossils, Ciocadia, leaf assemblage, Middle Miocene.

Rezumat. Noi contribuţii la flora miocen medie de la Ciocadia (partea întâi). În acest articol sunt reevaluate resturile macroscopice de plante fosile de vârstă badenian superioară-sarmaţian inferioară (Miocen mediu) din zona Ciocadia (nordul Olteniei) în acord cu taxonomia actuală şi sunt descrişi noi taxoni vegetali. Câteva determinări taxonomice anterioare au fost dovedite drept incorecte sau au fost actualizate. În acelaşi timp, au fost realizate noi determinări pentru taxoni interpretaţi greşit (*Sphaerites*, *Platanus*) sau pentru taxoni doar semnalaţi sau figuraţi (*Cystoseirites*, *Tetraclinis*, *Cunninghamia*, *Glyptostrobus*, *Picea*).

Cuvinte cheie: plante fosile, Ciocadia, asociaţie de frunze fosile, Miocen mediu.

INTRODUCTION

New and so far undescribed vegetal remains of the Ciocadia river fossil flora have been studied. The Ciocadia fossil flora is the richest and the most important Upper Badenian-Lower Sarmatian flora from Romania (ŢICLEANU, 1984; PARASCHIV, 2005, 2008a, b) with more than 40 taxa consisting of leaves, fruits, seeds and flowers (Table 1). This study is planned to complete the knowledge of Cenozoic floras from Romania. In several parts, we start to revise and add new taxa (PARASCHIV, 2008b) for some floras of Oltenia Province (Forecarpathian Basin). POPESCU (1953), TUDOR (1955), MARINESCU (1969) and HUICĂ (1994) studied in detail the Ciocadia Valley's geology and stratigraphy. The fossil plants are preserved in dark grey marls of the so-called "Spirialis Marls" unit, which represent the Late Badenian (Kossovian) and laminated marls of the Early Sarmatian (Volhynian).

MATERIAL AND METHODS

New leaves, fruits, seeds, and flower impressions were identified only on the basis of macro-morphological features because cuticles are not preserved. The fossil material is preserved mostly as impressions, rare as compressions with the organic matter calcified. For detailed observations and studies of the fossil remains a binocular magnifying glass was used. The specimens are housed in the collections of the Paleobotanical Branch of the National Museum of Geology of the Geological Institute of Romania, Bucharest. All specimens are labelled with the locality abbreviation between BCI.0127 and BCI.0368. The accepted morphological terminology used is mainly based on HICKEY (1979). Systematic organization and taxonomic terminology in this article are based on the works of KIRK et al. (2008), BRODIE & LEWIS (2007), KUBITZKI (1990) and TAKHTAJAN (2009).

Systematic Paleobotany

We outline in this chapter new species or undescribed/unfigured species in the Ciocadia record.

Phylum Eumycota (Fungi) CAVALIER-SMITH 1993
Class Ascomycota CAVALIER-SMITH 1998
Order Xylariales NANNFELDT 1932
Family Sphaeriaceae FRIES 1825 (=Xylariaceae TULASNE & C. TULASNE 1861)
Genus *Sphaerites* UNGER 1850
Sphaerites sp.
Pl. I, Fig. 1.

Material: BCI.0327, BCI.0535.
Description. Perithecia impressions of some saprophyte and parasite stromatic ascomycetous fungi, fixed on angiosperm leaves. Spherical fruitbody or carbonified mycelia up to 3 mm in diameter are preserved. The perithecia are ring structured and is represented by dark spherical corps with rounded inner depressions and a central ridge or hole in the middle is presented. Almost all the perithecia are disposed on the superior part or grouped in clusters in the central part of the leaves.

Remarks. Such fossils are reported also from Slătioara (Badenian-Sarmatian), Morilor Valley (Sarmatian), Tirol (Panonnian), Chiuzbaia (Pontian), Borsec (Dacian).

Phylum Ochrophyta CAVALIER-SMITH 1995
Class Phaeophytae KJELLMAN 1891
Order Fucales KYLIN 1917
Family Cystoseiraceae KUETZING 1843
Genus *Cystoseirites* STERNBERG 1833
Cystoseirites partschii STERNBERG 1833
Pl. I, Figs. 2, 3.

Material: BCI.0140, BCI.0570.
Description. Impressions of parenchymatous thalli fragments, dichotomously ramified, without holdfast. The thalli consist on a principal axis where are inserted numerous blades, branches and floats (or pneumatocysts). The length of the floats is 17 to 15 mm, and the diameter is of 5-6 mm. The pneumatocysts are strangulated several times (2-4) and distally ended with dichotomic filaments.
Remarks. Fragments of *Cystoseirites* thalli are frequently found in the Middle Miocene deposits of Romania, at Slătioara (Badenian-Sarmatian), Morilor Valley (Sarmatian), Tâmpa (Sarmatian), Daia-Săcădate (Sarmatian), Feleac (Sarmatian), Racşa (Sarmatian), Cavnic (Sarmatian).

Phylum Pinophyta CRONQUIST 1996
Class Pinopsida BURNETT 1835
Order Cupressales BROMHEAD 1838
Family Cupressaceae RICHARD ex BARTLET 1830
Genus *Tetraclinis* MASTERS 1892
Tetraclinis salicornioides (UNGER 1841) Z. KVAČEK 1989
Pl. I, Figs. 4, 5, 6, 7.

Material: BCI.0270, BCI.0298, BCI.0619, BCI.0626.
Description. Twig fragments with attached/detached articles (leaves) or seed compressions. Foliage twigs are mostly opposite branching, dichotomously ramified (until the fourth order). The scale-like leaves are polygonal shaped or elongated, flattened distally, with the base concave. Longitudinal nervation is obvious and divergent ribs go opposite to the main vein toward the upper part of the leaf. Seeds have two wings, equally, membranous, ovate to subglobulose in shape, or reniform, symmetrically disposed on the body. The central body of the seed is subcylindrical to triangular, with rounded base and bilobed micropylar tip.
Remarks. *Tetraclinis* is often found in the Cenozoic deposits of Romania at Bizuşa (Early Oligocene), Corneşti-Aghireş (Oligocene), Almaşului Valley (Oligocene), Coruş (Acvitanian), Pâncota (Badenian), Slătioara (Badenian-Sarmatian), Tâmpa-Deva (Sarmatian), Luncşoara (Sarmatian), Morilor Valley (Sarmatian), Borod-Borozel (Pannonian), Cornițel (Pannonian), Crişului Valley I-II (Pannonian), Vadu-Crişului (Pannonian), Chiuzbaia (Pontian).

Family Taxodiaceae WARMING 1884
Genus *Cunninghamia* R. BROWN ex RICHARD & A. RICHARD in A. RICHARD 1826
Cunninghamia sp.
Pl. I, Figs. 8, 9.

Material: BCI.0201, BCI.0580.
Description. Impressions of branches with needle-like leaves of 15 mm length and 2 mm wide, short-petiolate, disposed spirally around the stem and curved upward; after fossilization the leaves have alternate arrangement. The apex of the leaves is softly spined.
Remarks. *Cunninghamia* remains are rarely found in the Cenozoic deposits of Romania at Tâmpa (Badenian), Morilor Valley (Sarmatian), Auşeu (Sarmatian), Valea-de-Criş (Pannonian), Neagră Valley (Pannonian), Băile Homorod (Pannonian), Chiuzbaia (Pontian).

Genus *Glyptostrobus* ENDLICHER 1847
Glyptostrobus europaeus (BRONGNIART 1833) UNGER 1850
Pl. I, Fig. 10.

Material: BCI.0245, BCI.0248.
Description. Fertile deciduous shoot fragments (but without preserved cones) up to 30 mm in length with scale-like leaves, helically arranged on the stem. The leaves are ad-pressed, squamous, imbricated, with ad-axial surface convex, base decurrent and acuminate and incurved apex.

Remarks. Without preserved cuticle such twigs are morphologically indistinguishable from another taxodiacean, the extinct *Quasisequoia couttsiaei* (KUNZMANN 1999), but we plead for the previously taxon because of its high frequency in the Cenozoic deposits of Romania: the Jiu Valley (Late Oligocene-Egerian), Slătioara (Badenian-Sarmatian), Morilor Valley (Sarmatian), Fizeş (Sarmatian), Racşa (Sarmatian), Luncşoara (Sarmatian), Daia and Săcădate (Sarmatian), Borod-Borozel (Pannonian), Cornițel (Pannonian), the Crişului Valley II (Pannonian), Delureni (Pannonian), Tirol (Pannonian), Oaş (Pannonian-Pontian), Băița (Pontian), Sărmăşag-Chieşd (Pontian), Derna (Pontian), Sinersig (Pontian), Biborțeni (Pontian), Chiuzbaia (Pontian), Derna (Pontian), Borsec (Dacian).

Order Pinales DUMORTIER 1829
Family Pinaceae LINDLEY 1836
Genus *Pinus* LINNAEUS 1753
Pinus sp.
Pl. I, Fig. 11; Pl. II, Figs. 1, 2.

Material: BCI.0336, BCI.0338, BCI.0527.
Description. Compressions of small male cones of ?2.4 mm length and 3 (5) mm wide. The cones are composed of spirally arranged microsporophylls. There is obviously the central axis of the cone (microstrobilus) and the microsporophylls (modified leaves) and even some microsporangia, which bear the pollen sacs.
Remarks. Such cones are present only for a short period of time in the axil of a scale leaf (during spring or, rarely in autumn), clustered around the bases of young shoots and falling as soon as they shed their pollen. The fossil distribution in Romania: Corneşti-Aghireş (Oligocene), Slătioara (Badenian-Sarmatian), Morilor Valley (Sarmatian), Valea Neagră (Pannonian), Cornițel (Pannonian), Borsec (Dacian).

Pinaceae sp.
Pl. II, Figs. 3, 4.

Material: BCI.0244, BCI.0553.
Description. The compression of a incomplete young branchlet of ?28 cm length and 13 (to 5) mm wide, strongly incurved, asperous in texture. The shoot presents four obvious growth increments, which are generated by the annual rhythms. The surface of the bark is ornamented with large rhomboidal scales in the portions between the growth rings and imbricate fish-like scales in the growth areas. All the scales are disposed helically on the branchlet, representing the insertion scars of the leaves. It is worth mentioning that the growth sections of the branchlet are separated by two distal strangulations, which correspond to flexure points.
Remarks. There are not too many such fossils described because of the scarce diagnostic elements. In our case, only the *Pinaceae* family presents such characters. In Romania similar branchlets were found at Borsec (Dacian), assign to *Pinus leucodermis* ANTOINE vel *nigra* s.l.? by POP E. (1936).

Genus *Picea* A. DIETRICH 1824
Picea sp.
Pl. II, Figs. 5, 6.

Material: BCI.0339, BCI.0609.
Description. Small winged seed compressions of 11 (12) mm length and 4 mm wide. The seed is held in a shallow cup, covered fully on the one side but not at all on the other. Seed is sub-triangular, 3-4 mm, spiny. Wing elliptic, asymmetrical, base not or very slightly thickened and distally rounded.
Remarks. *Picea* seeds are cited in Romania from: Slătioara (Badenian-Sarmatian), Morilor Valley (Sarmatian), Cornițel (Pannonian), Chiuzbaia (Pontian).

Phylum Magnoliophyta CRONQUIST 1996
Class Magnoliopsida (*Dicotyledons*) BRONGNIART 1843
Order Laurales PERLEB 1826
Family Lauraceae JUSSIEU 1789
Genus *Laurophyllum* GOEPPERT 1857
Laurophyllum sp.
Pl. II, Figs. 7, 8.

Material: BCI.0306, BCI.0135.
Description. Impression of specimens of lanceolate to elliptic, obovate leaves of entire margin (7-8 cm long and 1.5 - 3 cm wide), with strong petiole, midrib slightly curved, strong evidenced, base cuneate, apex acute to acuminate, thick coriaceous texture. The venation is eucamptodromous, secondary veins regularly widely spaced, arch-like, looping near the margin, no clear detail of higher order venation observable.

Remarks. These are typical lauroid leaves, but without preserved cuticle, it is impossible to relate a precise species. *Laurophyllum* is very commonly found in Cenozoic deposits of Romania at: Coaş (Early Oligocene), Bizuşa (Early Oligocene), Cornești-Aghireş (Oligocene), the Jiu Valley (Late Oligocene-Egerian), Coruş (Acvitanian), Pâncota (Badenian), Căstău (Badenian), Slătioara (Badenian-Sarmatian), Borod (Sarmatian), Racşa (Sarmatian), Feleac (Sarmatian), Morilor Valley (Sarmatian), Băile Săcel (Sarmatian), Târnpa-Deva (Sarmatian), Luncşoara (Sarmatian), Daia and Săcădate (Sarmatian), Cornițel (Pannonian), Crişului Valley I-II (Pannonian), Delureni (Pannonian), Vadu-Crişului (Pannonian), Băița (Pontian), Chiuzbaia (Pontian).

Table 1. Summary of revised floristic composition of the Ciocadia fossil flora.
Tabel 1. Compoziția floristică revizuită a florei fosile de la Ciocadia.

Taxa	Țicleanu (1984)	Paraschiv (2005)	Paraschiv & Sebe (2007)	Paraschiv (2008 a)	Paraschiv (2008 b)
Sphaerites sp.				x (Δ) (Φ)	
Cystoseirites partschii Sternberg				y (Δ) (Φ)	
Eostangeria cf. *ruzinciniana* (Palamarev, Petkova et Uzunova) Palamarev & Uzunova					♠
Tetraclinis salicornioides (Unger) Z. Kvaček	—♠	—♠ (Δ)		● —♠ (Δ) (Φ)	
Cunninghamia sp.				—♠ (Δ)	
Glyptostrobus europaeus (Brongniart) Unger		—♠ (Δ)		—♠ (Δ) (Φ)	
Pinus sp.	♠ ●	● (Δ) ▫ (Δ)		● ♠ ▫ (Δ)	
Picea sp.				● (Δ) (Φ)	
Pinaceae sp.				— (Δ) (Φ)	
Laurophyllum sp. 1	♠	♠ (Δ)		♠ (Δ)	
Laurophyllum sp. 2		♠ (Δ)		♠ (Δ) (Φ)	
Daphnogene polymorpha (Al. Braun) Ettingshausen	♠	♠ (Δ)		♠ (Δ)	
Platanus sp.		● (Δ)			
Berberis sp.		♠ (Δ)			
Fagus silesiaca Walther & Zastawniak				♠ (Δ)	
Quercus kubinyii Kováts ex Ettingshausen	♠	♠ (Δ)		♠ (Δ) (Φ)	
Quercus gigas Goeppert emend. Walther & Zastawniak		♠ (Δ)		♠ (Δ) (Φ)	
Betula cf. *macrophylla* (Goeppert) Heer	♠				
Betula longisquamosa Mädler		● (Δ)		● (Δ) (Φ)	
Alnus sp.		▫ (Δ)		▫ (Δ) (Φ)	
Carpinus sp. div.	■	■ (Δ)		■ (Δ) (Φ)	
Myrica sp.				♠ (Δ)	
Juglans sp.		■ (Δ)		■ (Δ) (Φ)	
Carya denticulata (Weber) W. Schimper	♠				
Engelhardia orsbergensis (Wessel & Weber) Jähnichen, Mai & Walther	♠	♠ (Δ)		♠ (Δ) (Φ)	
Engelhardia macroptera (Brongniart) Unger				■ (Δ) (Φ)	
Byttneriophyllum sp.		■ (Δ)		■ (Δ) (Φ)	
Ulmus sp.	■	■ (Δ)		■ (Δ)	
Cedrelospermum sp.		■ (Δ)	■		■
Leguminosites parschlugianus (Unger) Kovar-Eder & Z. Kvaček	■♠			■♠ (Δ) (Φ)	
Podocarpium podocarpum (Al. Braun) Herendeen		♠ (Δ)			
Acer sp. div.	■	■ (Δ)		■ (Δ) (Φ)	
Ziziphus sp.		♠ (Δ)		♠ (Δ) (Φ)	
Hedera auriculata Heer				♠ (Δ)	
Fraxinus macroptera Ettingshausen		■ (Δ)		■ (Δ) (Φ)	
Dicotylophyllum sp. 1	♠	♠ (Δ)		♠ (Δ)	
Dicotylophyllum sp. 2	♠	♠ (Δ)			
Dicotylophyllum sp. 3	♠				
Dicotylophyllum sp. 4	♠				
Dicotylophyllum sp. 5	♠				

Explanations: ♠ - leaves, leaflets; ● - seeds; ■ - fruits, involucres, bracts, samaras, pods; — - twigs, branches; ▫ - inflorescences, flowers; **x** - fungal mycelium; **y** - algal thalli; (Δ) - undescribed; (Φ) - unfigured.
Explicații: ♠ - frunze, foliole; ● – semințe; ■ - fructe, involucre fructifere, bractee, samare, păstăi; — - crengi, ramuri; ▫ - inflorescențe, flori; **x** - micelii fungale; **y** - tal de alge; (Δ) - fără descriere; (Φ) - fără figurație.

Order Hamamelidales Grisebach 1854
Family Platanaceae T. Lestiboudois ex Dumortier 1829
Genus *Platanus* Linnaeus 1753
Platanus sp.
Pl. II, Figs. 9, 10.
Material: BCI.0303, BCI.0315.

Description. Single-seeded achenes (7 mm length and 1 mm wide) with a hairy tuft at the base, which aid wind dispersal. The hairy tuft from the base of each achene is made by thin stiff bristle fibres attached in a ring form. The seed body is liniar-obovate, widened distally and ended with a hairy stigma. There are no remains of fruit heads preserved, but only numerous detached achenes.
Remarks. Achenes of *Platanus* are founded also in the Morilor Valley (Sarmatian) flora.

RESULTS AND DISCUSSIONS

In the previous work of PARASCHIV (2008a) at the page 38, it was reported the presence of *Fungi* div. sp. in the fossil flora of Ciocadia, but devoid of diagnosis and figuration. Now we clearly describe and figure the taxon under its right name, *Sphaerites* sp. *Cystoseirites partschii* is only signalled (PARASCHIV, 2008a) in Ciocadia, and now we bring the taxon into the light. Rare findings like seeds of *Tetraclinis salicornioides* are for the first time described in Romania. The taxon *Cunninghamia* vel *Cephalotaxus* sp. (PARASCHIV, 2008a) should be replaced with *Cunninghamia* sp. after refined determinations. Male cones of *Pinus* are firstly reported from the Miocene deposits of the Forecarpathian Basin. Another taxon revised from PARASCHIV (2008a) is *Cupressaceae* sp. indet. p. 38, fossil shoots, which belong more exactly to *Pinaceae* family due to the presence of annual growth rings. Due to leaf homeomorphism, the determination of *Laurophyllum* has little systematic value, but without preserved cuticle, we are unable to advance further. The unknown affinity of *Seminae* indet. (PARASCHIV, 2005a, p. 132, Pl. IV, fig. 1) was elucidated after studying the achenes of *Platanus* in herbaria and in the fossil flora of the Morilor Valley. In Table 1, we placed all the taxa known until now from the Ciocadia fossil flora. Most of them are valid but require much more attention because of the poor description and figuration.

CONCLUSIONS

This is the first part of a series of contributions, which will clarify the floristic and vegetation aspects of the Miocene fossil floras of Oltenia Province. The floristic composition of Ciocadia site is similar to other coeval floras of the Forecarpathian Basin (the Morilor Valley, Pârlagele, Slătioara, Pătârlagele) or Transylvanian Basin (Căstău-Orăştie, Hăşdate) but its importance is increased due to its richer taxa.

ACKNOWLEDGEMENTS

We would like to thank Vlad Codrea and Stănilă Iamandei for their valuable comments and suggestions to the first version of the manuscript. This work was supported by the grants ID_442/2007 and ID_584/2008, financed by CNCSIS (the National University Research Council) and also by the grant POSDRU/107/1.5/S/80765 of the European Social Fund.

REFERENCES

BRODIE J. & LEWIS J. 2007. *Unravelling the algae, the past, present and future of algal systematics.* The Systematics Association. Special Volume Series 75. CRC Press, Taylor & Francis Group. Boca Raton: 376 pp.

GIVULESCU R. 1973. *Sur quelques restes de Cunninghamia du Neogene de Roumanie.* Revue Roumaine de Geologie, Geophysique et Geographie, Serie de Geologie, Bucureşti. **17**(1): 131-134.

HICKEY L. J. 1979. *A revised classification of the architecture of Dicotyledonous leaves.* In METCALFE R. C. & CHALK L (Editors): *Anatomy of the Dicotyledons, Systematic anatomy of leaf and stem, with a brief history of the subject.* Oxford. **1**: 25-39.

HUICĂ I. V. 1994. *Recherches géologiques sur le Badénien et la Sarmatien de la region de Ciocadia-Săcel (l'anticlinal Săcel-Tg. Jiu, Dépression Gétique). The Miocene from the Transylvanian Basin, Romania*, Edit. Carpatica. Cluj-Napoca: 163-170.

KIRK P. M., CANNON P. F., MINTER D. W., STALPERS J. A. 2008. *Dictionary of the Fungi.* Tenth Edition. Cromwell Press. Trowbridge. 771 pp.

KUBITZKI K. 1990. *The families and genera of vascular plants.* Volume I. *Pteridophytes and Gymnosperms.* K. U. Kramers & P. S. Green (Editors). Springer Verlag. Berlin. 404 pp.

KUNZMANN L. 1999. *Koniferen der Oberkreide und ihre relikte im Tertiär Europas.* Abhandlungen des Staatlichen Museums fur Mineralogie und Geologie zu Dresden. Dresden. **45**: 3-191.

MARINESCU F. 1969. *Precizări stratigrafice privind Sarmaţianul şi Meoţianul din Nordul Olteniei.* Dări de Seamă ale Şedinţelor, Institutul Geologic al României. Bucureşti. **54**(3): 153-162.

PARASCHIV V. 2005a. *The fossil flora of the Ciocadia Valley, Western Dacian Basin, Romania (II).* Acta Horti Botanici Bucurestiensis. Universitatea din Bucureşti. Grădina Botanică „Dimitrie Brândza". Bucureşti. **32**: 127-132.

PARASCHIV V. 2005b. *The Miocene flora of Oltenia Province.* The Fifth Romanian Symposium on Paleontology, dedicated to the Centennial of the Laboratory of Paleontology, University of Bucharest, 15-17 September 2005, Ars Docendi, Bucureşti: Abstracte: 36.

PARASCHIV V. 2005c. *Flori şi seminţe fosile din depozitele Miocene ale Olteniei.* Universitatea din Bucureşti. Grădina Botanică „Dimitrie Brândza". Sesiunea de comunicări ştiinţifice. Ediţia a XII-a, 3 decembrie 2005. Bucureşti: Abstracte: 5.

PARASCHIV V. 2006a. *Noutăţi paleobotanice din depozitele Sarmaţiene ale Olteniei.* Universitatea din Bucureşti, Grădina Botanică „Dimitrie Brândza", Sesiunea de comunicări ştiinţifice. Ediţia a XIII-a, 2 decembrie 2006. Bucureşti: 6.

PARASCHIV V. 2006b. *Flora Sarmaţiană din Oltenia.* Unpublished PhD Thesis. Universitatea din Bucureşti. 263 pp.

PARASCHIV V. 2007. *New species of fossil plants from the Sarmatian deposits of Oltenia.* The sixth edition of the Romanian Symposium on Paleontology. 21-23 September 2007. Universitatea „Alexandru Ioan Cuza" Iaşi. Abstracts: 33-34.

PARASCHIV V. 2008a. *New data concerning the fossil flora of the Ciocadia Valley, Western Dacian Basin, Romania.* Acta Horti Botanici Bucurestiensis. Universitatea din Bucureşti. Grădina Botanică „Dimitrie Brândza". Bucureşti. **35**: 36-42.

PARASCHIV V. 2008b. *New Sarmatian plant macroremains from Oltenia region (Romania), Part I.* Acta Palaeontologica Romaniae. Universitatea „Alexandru Ioan Cuza" Iaşi. **6**: 279-286.

PARASCHIV V. 2008c. *The Upper Miocene flora and vegetation of Western Dacian Basin.* Proceedings of the 33-rd International Geological Congress. 33 IGC – 2008, 6-14 August 2008. Oslo: Abstracts: 15.

PARASCHIV V. 2008d. *Paleofloristic diversity of the Sarmatian deposits (Middle Miocene) from southern Romania.* Proceedings of the 12-th International Palynological Congress (IPC-XII 2008) and of the 8-th International Organisation of Palaeobotany Conference (IOPC-VIII 2008), 30 August-5 Septembrie, Bonn, Germany: Abstracts: 290-291.

PARASCHIV V. 2010. *The Sarmatian flora of south-west Romania.* Proceedings of the 8th European Palaeobotany - Palynology Conference, 6-10 July 2010 - Budapest, Hungary. Hungarian Natural History Museum. Budapest: Abstracts: 186.

PARASCHIV V. & SEBE O.-G. 2007. *Fossil Cedrelospermum fruits from Oltenia (Romania).* Drobeta. Seria Ştiinţele Naturii. Muzeul Regiunii Porţilor de Fier. Drobeta-Turnu Severin. **17**: 7-16.

PARASCHIV V., ANTONIADE G.-C., SEBE O.-G. 2008. *The Upper Miocene flora and vegetation of South-West Romania.* Conferinţa Anuală a Societăţii Geologice a României (SGR), 4-5 octombrie 2008. Institutul Geologic al României. Muzeul Naţional de Geologie. Bucureşti: Abstracte: 44.

POP E. 1936. *Flora Pliocenică de la Borsec.* Universitatea Regele Ferdinand I Cluj. Cluj-Napoca. 190 pp.

POPESCU G. 1953. *Cercetări geologice în regiunea Ciocadia-Piţicu-Baia de Fier (Depresiunea Getică).* Dări de Seamă ale Şedinţelor. Institutul Geologic al României . Bucureşti. **39**: 15-25.

TAKHTAJAN A. 2009. *Flowering plants.* Second edition. Springer Science. Amsterdam. 871 pp.

TUDOR M. 1955. *Stratigrafia şi fauna depozitelor Tortoniene şi Sarmaţiene dintre Jiu şi Olteţ.* Edit. Academiei Române. Bucureşti. 118 pp.

ŢICLEANU N. 1984. *Contributions to the study of the Upper Badenian flora from Romania.* Dări de Seamă ale Şedinţelor. Institutul Geologic al României. Bucureşti. **68**(3): 135-150.

Paraschiv Valentin
Geological Institute of Romania, National Museum of Geology,
Kiseleff Ave, No. 2, Sect. 1, 011345, Bucharest, Romania,
E-mail: paleovaly@yahoo.com

Sebe Oana-Gabriela
Geological Institute of Romania, National Museum of Geology,
Kiseleff Ave, No. 2, Sect. 1, 011345, Bucharest, Romania,
E-mail: oana_sebe@yahoo.com

Received: March 31, 2011
Accepted: July 18, 2011

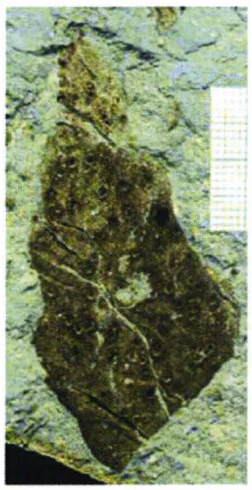


Fig. 1

Fig. 2

Fig. 3

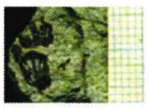


Fig. 4

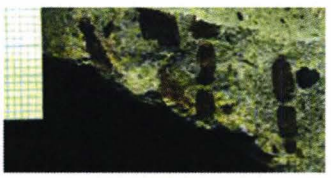


Fig. 5

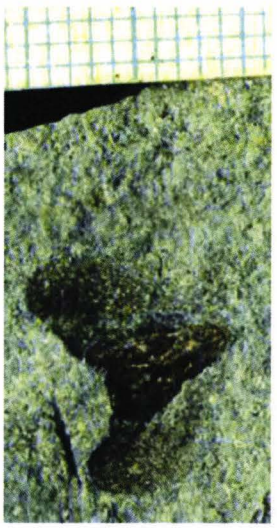


Fig. 7

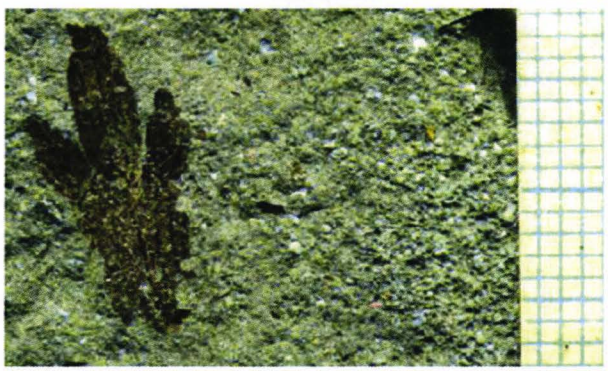


Fig. 6

Fig. 8

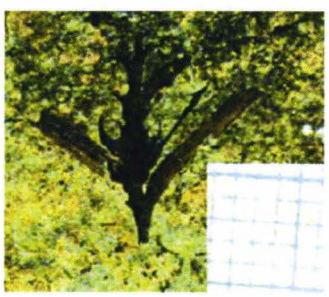


Fig. 9

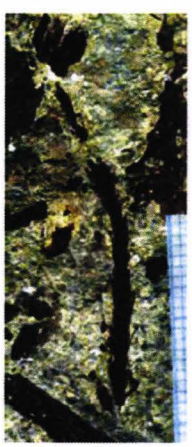


Fig. 10

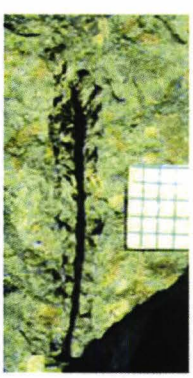


Fig. 11

PLATE I

Fig. 1 - *Sphaerites* sp.
Fig. 2, 3 - *Cystoseirites partschii* STERNBERG
Fig. 4, 5, 6, 7 - *Tetraclinis salicornioides* (UNGER) Z. KVAČEK
Fig. 8, 9 - *Cunninghamia* sp.
Fig. 10 - *Glyptostrobus europaeus* (BRONGNIART) UNGER
Fig. 11 - *Pinus* sp.

Fig. 1

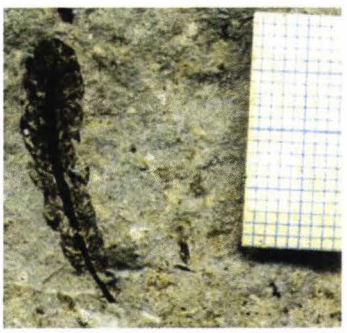


Fig. 2

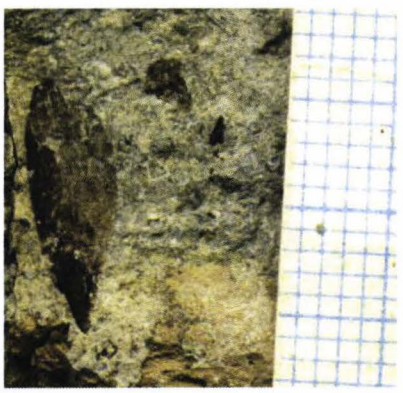


Fig. 8

Fig. 9

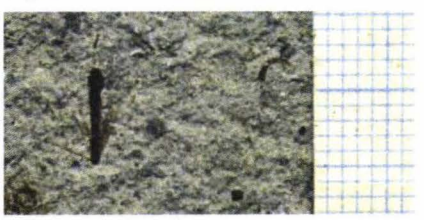


Fig. 10

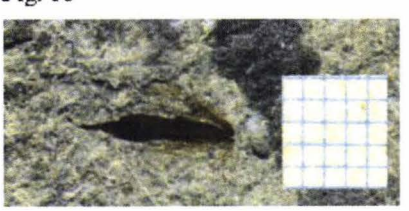


Fig. 3

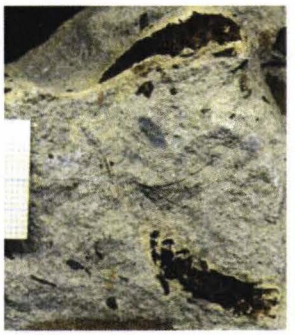


Fig. 4

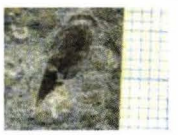


Fig. 5

Fig. 6

Fig. 7

PLATE II

Fig. 1, 2 - *Pinus* sp.
Fig. 3, 4 - *Pinaceae* sp.
Fig. 5, 6 - *Picea* sp.
Fig. 7, 8 - *Laurophyllum* sp.
Fig. 9, 10 - *Platanus* sp.

PHYLLOCERATIDS FROM THE UPPER JURASSIC DEPOSITS OF HĂGHIMAŞ MTS. (THE EASTERN CARPATHIANS – ROMANIA)

GRIGORE Dan

Abstract. This paper deals with the taxonomic study of the Phylloceratids species found in the Kimmeridgian-Tithonian deposits from Ghilcoş and Ciofronca (Hăghimaş Mts). The number of species identified here reached 13 taxa. Also, there are revised all the species and specimens described by the previous authors: HERBICH (1878), NEUMAYR (1871, 1873) and PREDA (1973). *Phylloceras leptoptychum* and *Ph. bekasense* described HERBICH (1878) are proposed for removal from the nomenclature of species.

Keywords: Phylloceratids, taxonomy, Hăghimaş, Carpathians, Romania.

Rezumat. Phylloceratide din Jurasicul superior din Munţii Hăghimaş (Carpaţii Orientali – România). În lucrare este prezentat studiul taxonomic al speciilor din grupul Phylloceratina găsite în depozitele kimmeridgian-tithoniene din Ghilcoş şi Ciofronca (Munţii Hăghimaş). Numărul speciilor cunoscute de aici ajunge acum la 13. De asemenea, în această lucrare sunt revizuite toate speciile/specimenele descrise din zonă de autorii anteriori: HERBICH (1878), NEUMAYR (1871, 1873) şi PREDA (1973). Speciile *Phylloceras bekasense* şi *Ph. leptoptychum* descrise de HERBICH (1878) sunt propuse aici pentru radiere din nomenclatorul speciilor (*nome nudum*).

Cuvinte cheie: Phylloceratide, taxonomie, Hăghimaş, Carpaţi, România.

INTRODUCTION

The outcrops (F1, F2, F17 in GRIGORE et al., 2009 and 2011) that yielded the studied fauna are situated in Hăghimaş Mts. These outcrops are included in the Cheile Bicazului – Hăghimaş National Park. The group of Phylloceratids is well represented in this region (number of species and specimens), two acmes being registered: first in Platynota Zone and the second, in Acanthicum Zone (Loryi Horizon). In this paper, there are revised all the phylloceratid specimens described from these areas by previous authors; it was the opportunity to reassess two Herbich's species: *Phylloceras bekasense* and *Ph. leptoptychum.*

Systematics

Abbreviations for the measurements, collections and outcrops:

Dmax = maximal diameter
Dph = phragmocone diameter
D = measured diameter
U = diameter of umbilicus
H = whorl height
W = whorl width

GIR = Geological Institute of Romania
GIA = Geological Institute of Austria (Bundesanstalt)
UBB = "Babeş Bolyai" University from Cluj Napoca
LGB = Geology Laboratory of Bucharest University
LPB = Palaeontology Lab. of Bucharest University
MPN = Museum of Natural Sciences - Piatra Neamţ

F1 = Outcrop from western Ghilcoş walls
F2 = Outcrop from north-western Ghilcoş slope
F17 = Outcrop from "Ciofronca"; all in GRIGORE et al, 2009
A, D... K = studied sections (GRIGORE, 2002, 2011)

Suborder Phylloceratina ARKELL, 1950
Family Phylloceratidae ZITTEL, 1884
Subfamily Phylloceratinae ZITTEL, 1884
Genus *Phylloceras* SUESS, 1865
Phylloceras isotypum (BENECKE, 1866)
Pl. 1, Fig. 2

1866 *Ammonites isotypus*-BENECKE; p. 184; Pl. 7, Figs. 1; 2.
1871 *Phylloceras isotypum* BENECKE-NEUMAYR; p. 314; Pl. 13, Fig. 3.
1872 *Phylloceras isotypum* BENECKE-GEMMELLARO; p. 30; Pl. 1, Fig. 1.
1873 *Phylloceras isotypum* BENECKE-NEUMAYR; p. 158.
1878 *Phylloceras isotypum* BENECKE-HERBICH; p. 140; Pl. 2, Figs. 1a-b.
1896 *Phylloceras isotypum* BENECKE-CANAVARI; p.32; Pl. 4, Figs. 4a-b; 5; 6.
1973 *Phylloceras isotipum* BENECKE-PREDA; Pl. 3, Fig. 2.
1979 *Phylloceras isotypum* (BENECKE, 1866)-SAPUNOV; p. 26; Pl. 1, Figs. 2; 3a-b.
1986 *Phylloceras isotypum* (BENECKE)-SARTI; p. 484.
1993 *Phylloceras isotypum* (BENECKE, 1866)-SARTI; p. 49.

Material: LRh13G7, LRh14F7 Grigore Collection in GIR; NEUMAYR's specimens (1871): Collection of GIA; originates from grey sandy limestones – Ghilcoş outcrop (F2) and red nodular limestones – Ciofronca outcrop. Herbich's specimen: Collection of UBB originates from red nodular limestones – Ciofronca outcrop. Preda's specimen: Collection of MPN; originates from grey nodular limestones – Ghilcoş outcrop.

Table 1. Measurements of *Phylloceras isotypum* (BENECKE, 1866) specimens.
Tabel 1. Măsurători ale exemplarelor de *Phylloceras isotypum* (BENECKE, 1866).

Specimen	Dmax	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	-	110	7	64	40	0.06	0.58	0.36	0.62
Herbich specimen	-	69	3	38	27	0.04	0.55	0.39	0.71
LRh13G7	55	55	4	35	24	0.07	0.64	0.44	0.68
LRh14F7	35	35	3	20	15	0.08	0.57	0.43	0.75

After SARTI (1986) the species includes two morphotypes: *isotypum* (BENECKE, 1866) – with subrectangular section and radial ribbing and second one - *apenninicum* CANAVARI, 1896 – with large oval section and curved ribbing.

Remarks: LRh13G7 is a phragmocone (Pl. 1, Fig. 2) and LRh14F7, a juvenile (D = 35 mm) which preserve 1/3 of the living chamber, the specific ornamentation folded and with fine ribs, more visible on lateral sides.

Occurrence: Lower Kimmeridgian in Ghilcoş (F, G profiles) and Ciofronca outcrops; Kimmeridgian in Italy, Sesquinodosum /Beckeri interval in Bulgaria, former Yugoslavia.

Phylloceras saxonicum NEUMAYR, 1871
Pl. 1, Figs. 5, 6, 9

1871 *Phylloceras saxonicum*-NEUMAYR; p. 315; Pl. 13, Fig. 4; Pl. 14, Figs. 1a-b; 2.
1873 *Phylloceras saxonicum* NEUMAYR-NEUMAYR; p. 158.
1877 *Ammonites* (*Phylloceras*) *saxonicum* NEUMAYR-FAVRE; p. 30; Pl. 2, Fig. 8.
1878 *Phylloceras saxonicum* NEUMAYR–HERBICH; p. 140; Pl. 14, Fig. 2.
1973 *Phylloceras saxonicum* NEUMAYR-PREDA; Pl. 2, Fig. 1.
1976 *Phylloceras* cf. *saxonicum* NEUMAYR-JOLY; p. 172; Pl. 7, Fig. 3.
1979 *Phylloceras saxonicum* NEUMAYR-SAPUNOV; p. 26; Pl. 1, Fig. 6.

Material: LRh17M1, LRh18F6, LRh19W5.0, LRh40F2, LRh41J, LRh76T5.0, LRh83E1 Grigore Collection in GIR. Holotype: Collection of GIA - originates from limestone of Ghilcoş outcrop. Herbich's specimens: Collection of UBB - originates from red nodular limestones - Ghilcoş (F1) and Ciofronca outcrops. Preda's specimen: inv. 31MPN (Pl. 2, Fig. 1) in Collection of MPN - originates from reddish nodular limestones (W profile) – base of Ghilcoş outcrop.

Table 2. Measurements of *Phylloceras saxonicum* NEUMAYR, 1871 specimens.
Tabel 2. Măsurători ale exemplarelor de *Phylloceras saxonicum* NEUMAYR, 1871.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	98	98	98	3	56	28	0.03	0.58	0.29	0.50
Herbich specimen	250	-	-	-	-	-	-	-	-	-
Preda 31MPN specimen	100	100	71	5	45	23	0.07	0.63	0.32	0.51
LRh17M1	75	75	64	6	37	19	0.09	0.58	0.30	0.51
LRh18F6	63	75	63	5	35	19	0.08	0.56	0.30	0.54
LRh19W5,0	61	61	61	5	35	17	0.08	0.57	0.28	0.49
LRh40F2	53	53	53	4	30	15	0.07	0.57	0.28	0.50
LRh41J	75	75	75	5	45	22	0.07	0.60	0.29	0.49
LRh76T5,0	44	44	40	3	25	13	0.10	0.62	0.32	0.52
LRh83E1	46	40	40	3	24	13	0.07	0.60	0.32	0.54

Remarks: only LRh83E1 preserves a part from the living chamber the other being phragmocones. All specimens are medium or small in size (Table 2) and the best preserved is LRh17M1, which preserves the specific ornamentation. The Herbich's specimen is big sized and its suture line is presented by NEUMAYR (1871; Pl. 14, Fig. 2). Preda's specimen is also big in size but in bad condition of preservation (eroded).

Occurrence: Lower Kimmeridgian in Ghilcoş (W, T, F, M profiles) and Ciofronca outcrops; Early Kimmeridgian in Bulgaria, France, Switzerland and Madagascar.

Phylloceras consanguineum GEMMELLARO, 1876
Pl. 1, Figs. 4; 8 (*P. leptoptychum* HERBICH) 10a-b

1876 *Phylloceras consanguineum*-GEMMELLARO; p. 7; Pl. 15, Figs. 2; 3.
1876 *Ammonites praeposterius* FONTANNES-DUMORTIER & FONTANNES; p. 30; Pl. 6, Figs. 1; 2.
*1878 *Phylloceras leptoptychum*–HERBICH; p. 141; Pl. 1, Figs. 5a-b.

*1896 *Phylloceras consanguineum* GEMMELLARO-CANAVARI; p. 30; Pl. 4, Fig. 3 (Neotype).
1960 *Phylloceras* (*Phylloceras*) *consanguineum* GEMMELLARO-CHRIST; p. 56; Pl. 2, Fig. 1.
1973 *Phylloceras* (*Calliphylloceras*) *leptoptychum* HERBICH–PREDA; Pl. 2, Fig. 5; Pl. 4, Fig. 1.
1979 *Phylloceras consanguineum* GEMMELLARO–SAPUNOV; p. 25; Pl. 1, Fig. 1.
1986 *Phylloceras consanguineum* GEMMELLARO–SARTI; p. 484; Pl. 1, Figs. 3a-b.
1993 *Phylloceras consanguineum* GEMMELLARO–SARTI; p. 49.
1994 *Adabofoloceras consanguineum* (GEMMELLARO)–ZEISS & al.; p. 368; Pl. 1, Fig. 2.

Material: LRh16D3, LRh84A3, LRh85A1, LRh86K32, LRh87K32 Grigore Collection in GIR. Herbich's specimen (*Phylloceras leptoptychum*): inv. 2053 UC in Collection of UBB - originates from green sandy limestones – Ghilcoş outcrop. Preda's specimens: inv. 14aMPN, 62aMPN in Collection of MPN - both from grey nodular limestones; inv. 62bMPN originates from green sandstones – all from Ghilcoş outcrop.

Table 3. Measurements of *Phylloceras consanguineum* GEMMELLARO, 1876 specimens.
Tabel 3. Măsurători ale exemplarelor de *Phylloceras consanguineum* GEMMELLARO, 1876.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Neotype	91	-	91	6	53	28	0.07	0.58	0.31	0.53
Herbich 2053 UC (*P.leptoptychum*)	52	34	52	3	30	16	0.05	0.58	0.31	0.53
Preda 14aMPN specimen	64	64	64	4	38	21	0.06	0.59	0.33	0.55
Preda 62aMPN specimen	52	-	52	4	30	18	0.08	0.58	0.35	0.60
Preda 62bMPN specimen	46	-	46	3	27	18	0.06	0.59	0.39	0.67
LRh84A3	41	40	41	3	24	13	0.07	0.58	0.32	0.54
LRh85A1	32	-	30	2.5	18	11	0.08	0.60	0.37	0.61
LRh86K32	-	-	-	-	24	13	-	-	-	0.54
LRh87K32	26	-	26	2	15.5	9	0.08	0.60	0.35	0.58

Discussion: this species has raised concerns due to its morphology, however, most authors have finally put equal sign between taxa *Phylloceras consanguineum*, *P. praeposterius,* and *P. leptoptychum* presenting features and ornamental shells with identical morphometric features; i.e. *Phylloceras leptoptychum* HERBICH species become *nome nudum.*

Remarks: LRh16D3 and LRh86K32 are two fragments of big specimens, which preserve very well the specific ornamentation; the other are phragmocones, small in size of which LRh84A3 are the best preserved (not deformed). Preda's 14aMPN specimen is a large phragmocone very well preserved (Pl. 1, Fig. 4).

Occurrence: Kimmeridgian/Lower Tithonian - Divisum/Hybonotum interval (?) in Ghilcoş (K, D, A profiles) outcrop; Kimmeridgian/Lower Tithonian - Divisum /Verruciferum interval in Italy and Early Kimmeridgian in Bulgaria.

Subfamily Calliphylloceratinae SPATH, 1927
Genus *Calliphylloceras* SPATH, 1927
Calliphylloceras manfredi (OPPEL, 1865)
Pl. 1, Figs. 7, 12

1865 *Ammonites Manfredi*-OPPEL; p. 215; Pl. 57, Figs. 2a-c.
1871 *Phylloceras Manfredi* OPPEL-NEUMAYR; p. 333; Pl. 14, Fig. 8.
1973 *Phylloceras* (*Calliphylloceras*) *manfredi* OPPEL-PREDA; Pl. 5, Fig. 3; Pl. 18, Fig. 7.

Material: LRh23F6, LRh24F5 LRh25F4, LRh26W, LRh27W5.0, LRh28F5, LRh37A9, LRh38R1, LRh39F3 Grigore Collection in GIR. Preda's specimens: three in Collection of MPN - inv. 24aMPN (Pl. 18, Fig. 7) - originates from grey-greenish sandstones; 24bMPN (Pl. 5, Fig. 3) - originates from grey limestones; 24cMPN - originates from green nodular limestones; all from Ghilcoş outcrop (F2).

Table 4. Measurements of *Calliphylloceras manfredi* (OPPEL, 1865) specimens.
Tabel 4. Măsurători ale exemplarelor de *Calliphylloceras manfredi* (OPPEL, 1865).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D
Holotype	68	68	6	36	26	0.09	0.53	0.38	0.72
Preda 24aMPN specimen	59	59	5.5	24	8	0.09	0.41	0.14	0.33
Preda 24bMPN specimen	56	53	5	30	17	0.09	0.57	0.32	0.57
Preda 24cMPN specimen	28	26	4	13	10	0.15	0.50	0.38	0.77
LRh23F6	39	39	5	21	14	0.13	0.54	0.36	0.67
LRh24F5	34	34	4	18	11.5	0.12	0.53	0.34	0.64
LRh25F4	46	46	5	24	17	0.11	0.52	0.37	0.71
LRh26W	32	32	3.5	19	12	0.11	0.59	0.37	0.63
LRh27W5.0	25	25	3.5	14	11	0.14	0.56	0.44	0.78
LRh28F5	20.5	20.5	2.5	12	8.5	0.12	0.58	0.41	0.71
LRh37A9	35	35	4	19	13	0.11	0.54	0.37	0.68
LRh38R1	28	28	4	16	9.5	0.14	0.57	0.34	0.59
LRh39F3	41	34	4	19	15	0.12	0.56	0.44	0.79

Remarks: they are small to medium sized phragmocones with close parameters to the holotype. Two of Preda's specimens are large sized and preserve a small part of the living chamber (Table 4).

Occurrence: Lower Kimmeridgian in Ghilcoş (E, F, A, W, R profiles) outcrops; Oxfordian (to Lower Kimmeridgian?) in Switzerland and Austria.

Calliphylloceras benacense (CATULLO, 1847) in NEUMAYR, 1871
Pl. 1, Figs. 1, 3; ("*P. bekasense*" HERBICH) Pl. 2, Figs. 12 a, b

1847 *Ammonites benacensis*–CATULLO; p. 9; Pl. 13, Figs. 1a-b.
*1871 *Phylloceras benacense* CATULLO–NEUMAYR; p. 336; Pl. 15, Figs. 3a-c.
1873 *Phylloceras benacense* CATULLO–NEUMAYR; p. 159.
1877 *Phylloceras benacense* CATULLO–GEMMELLARO; p. 180; Pl. 15, Fig. 1; Pl. 17, Fig. 1.
1878 *Phylloceras benacense* CATULLO–HERBICH; p. 142.
?1878 *Phylloceras Bekasense*–HERBICH; p. 143; Pl. 3, Figs. 1a-b.
1976 *Calliphylloceras benacense* (CATULLO)–JOLY; p. 192; Pl. 10, Fig. 1.
1986 *Calliphylloceras benacense* (CATULLO)–SARTI; p. 485; Pl. 1, Fig. 1.
1993 *Calliphylloceras benacense* (CATULLO)–SARTI; p. 51.

Material: LRh20D3, LRh21D10, LRh22G1, LRh75A, LRh74B15, LRh78K23, LRh82A1 Grigore Collection in GIR. Herbich's specimen in the Collection of UBB - was found by HERBICH (1878, p. 142) and analysed by NEUMAYR (1873, p. 159); it is in bad condition of preservation.

Table 5. Measurements of *Calliphylloceras benacense* (CATULLO, 1847) specimens.
Tabel 5. Măsurători ale exemplarelor de *Calliphylloceras benacense* (CATULLO, 1847).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	72	-	72	-	43	25	-	0.62	0.35	0.58
Herbich specimen	152	152	152	15	88	50	0.10	0.58	0.33	0.57
LRh22G1	46	-	36	4	19	›12	0.11	0.53	0.33	0.63
LRh74B15	77	-	~77	~5	~48	›8	0.06	0.62	›0.10	›0.17
LRh75A3	76	75	65	4	39	20	0.06	0.60	0.31	0.51
LRh78K23	33	-	33	3	19	13	0.09	0.57	0.39	0.68
LRh82A1	52	49	48	5	28	17	0.10	0.58	0.35	0.61

Remarks: deformed (flattened) specimens from marly and silty deposits; all present the features of ~~the~~ Neumayr (1871) described specimen. LRh75A3 is the best preserved, with a long part of the living chamber deformed; LRh74B15 preserves also partially the fine ribbed wall of the conch (Pl. 1, Fig. 1).

Occurrence: Kimmeridgian – Divisum /Beckeri interval in Ghilcoş (K, G, A, D, B profiles) outcrops; Kimmeridgian - Italy (Northern and Sicily), Switzerland, Austria, India and Madagascar.

Calliphylloceras kochi (OPPEL, 1865) in ZITTEL, 1868
Pl. 1, Fig. 11

1865 *Ammonites Kochi*–OPPEL; p. 550
*1868 *Phylloceras Kochi* OPPEL–ZITTEL; p. 65; Pl. 6, Fig. 1; Pl. 7, Figs. 1; 2
1871 *Phylloceras Kochi* OPPEL–NEUMAYR; p. 337; Pl. 15, Figs. 4a-b
1876 *Ammonites gorgoneus* FONTANNES–FONTANNES & DUMORTIER; p. 36; Pl. 5, Fig. 1
1879 *Ammonites* (*Phylloceras*) *kochi* OPPEL–FAVRE; p. 24; Pl. 2, Figs. 8a-b
1879 *Phylloceras gorgoneum* FONTANNES–FONTANNES; p.4; Pl. 1, Fig. 4
1976 *Calliphylloceras kochi* (OPPEL)–JOLY; p. 224; Pl. 10, Fig. 4
1976 *Calliphylloceras kochi* (OPPEL)–AVRAM; p. 19; Pl.7, Figs.1a-b
1984 *Calliphylloceras kochi* (OPPEL)–SARTI; p. 485; Pl. 1, Figs. 2a-b
1994 *Calliphylloceras kochi* (OPPEL)–ZEISS; p. 370; Pl. 1, Fig. 5
Material: LRh1K38 Grigore Collection in GIR.

Table 6. Measurements of *Calliphylloceras kochi* (OPPEL, 1865) specimens.
Tabel 6. Măsurători ale exemplarelor de *Calliphylloceras kochi* (OPPEL, 1865).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	190	-	190	6	113	57	0.03	0.59	0.30	0.50
LRh1K38	56	35	~56	3.5	29	›14	0.08	0.52	›0.25	›0.48

Remarks: my specimen (Pl. 1, Fig. 11) is slightly deformed (provided by marls) and preserves ½ from the living chamber; also, it preserves partially the conch wall ornated with thin ribs, on the external side. By its features is more close to the Zittel specimen (in Zittel; Pl. 7, Fig. 1a-b).

Occurrence: Lower Tithonian (Semiforme Zone) in Ghilcoş (K profile) outcrop; Lower Tithonian in France; Tithonian in Switzerland, Czech Republic, Morocco and, Madagascar.

Genus *Holcophylloceras* SPATH, 1927
Holcophylloceras polyolcum (BENECKE, 1866) in NEUMAYR, 1871
Pl. 2, Fig. 4

1866 *Ammonites polyolcus*–BENECKE; p. 182; Pl. 8, Figs. 1a-b; 2.
*1871 *Phylloceras polyolcum* BENECKE–NEUMAYR; p.341; Pl. 17, Figs. 6; 7.
1873 *Phylloceras polyolcum* BENECKE–NEUMAYR; p. 159.
1878 *Phylloceras polyolcum* BENECKE–HERBICH; p. 144; Pl. 2, Figs. 2a-b.
1973 *Phylloceras* (*Holcophylloceras*) *polyolcum* BENECKE–PREDA; Pl. 2, Fig. 4; Pl. 9, Fig. 3.
1976 *Holcophylloceras polyolcum* (BENECKE)–JOLY; p. 255; Pl. 24, Fig. 1; Pl. 25, Fig. 1; Pl. 26, Fig. 1.
1979 *Holcophylloceras polyolcum* (BENECKE)–SAPUNOV; p. 30; Pl. 2, Figs. 3; 4; 5.
1993 *Holcophylloceras polyolcum* (BENECKE)–SARTI; p. 50.

Material: LRh7F7, LRh8E1, LRh9F3, LRh10F4 Grigore Collection in GIR. Herbich's specimens: Collection of UBB; figured specimen originates from greenish sandy limestones – Ghilcoş outcrop (F2); other specimens originate from red nodular limestones – Ghilcoş (F1) and Ciofronca outcrops. Preda's specimens: three in Collection of MPN: inv. 20aMPN (Pl. 2, Fig. 4) – originate from bluish nodular limestones (Platynota /Hypselocyclum interval); inv. 20bMPN (Pl. 9, Fig. 3) – originates from red nodular limestones; inv. 65MPN – originates from green sandy limestones; all the specimens are from Ghilcoş outcrop.

Table 7. Measurements of *Holcophylloceras polyolcum* (BENECKE, 1866) specimens.
Tabel 7. Măsurători ale exemplarelor de *Holcophylloceras polyolcum* (BENECKE, 1866).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	129	-	129	14	68	42.5	0.11	0.53	0.33	0.62
Herbich specimen	93	-	93	10	50	32	0.11	0.54	0.34	0.64
Preda 20aMPN specimen	69	64	57	8	31	~12	0.14	0.54	0.21	~0.39
Preda 20bMPN specimen	~59	-	55	9.5	28	~6	0.17	0.51	0.11	~0.21
Preda 65MPN specimen	93	-	81	11	51	~24	0.13	0.63	0.30	~0.47
LRh7F7	122	102	102	13	56	36	0.13	0.55	0.35	0.64
LRh8E1	107	106	107	12	59	35	0.11	0.55	0.33	0.59

Remarks: all the specimens are phragmocones, only LRh7F7 and LRh8E1 are the best preserved (Pl. 2, Fig. 4); from Table 7 we can see the variability of some parameter as the width in the juvenile stage.

Occurrence: Lower Kimmeridgian in Ghilcoş (E, F, W, K profiles) and Ciofronca outcrops; Kimmeridgian in Italy, Switzerland, India, and Madagascar.

Holcophylloceras mediterraneum (NEUMAYR, 1871) emended JOLY, 1976
Pl. 2, Figs. 6; 11

*1847 *Ammonites zignodianum*-D'ORBIGNY; p. 182
1871 *Phylloceras mediterraneum*-NEUMAYR; p. 340; Pl. 17, Figs. 2; 3; 4; 5
1877 *Phylloceras mediterraneum* NEUMAYR-GEMMELLARO; p. 182; Pl. 17, Fig. 2
1896 *Phylloceras mediterraneum* NEUMAYR-CANAVARI; p. 38; Pl. 5, Fig. 2
1973 *Phylloceras* (*Calliphylloceras*) *zignodianum* D'ORBIGNY–PREDA; Pl. 4, Fig. 2; Pl. 5, Fig. 4; *non* Pl. 2, Fig. 3 (= *Sowerbyceras loryi loryi*)
1976 *Holcophylloceras mediterraneum* (NEUMAYR)-JOLY; p. 249; Pl. 23, Fig. 5; Pl. 26, Fig. 4
1979 *Holcophylloceras mediterraneum* (NEUMAYR)-SAPUNOV; p. 29; Pl. 2, Fig. 2
1986 *Holcophylloceras mediterraneum* (NEUMAYR)-SARTI; p. 486
1993 *Holcophylloceras mediterraneum* (NEUMAYR)-SARTI; p. 50

Material: LRh2F6, LRh6F1, LRh31F1 and morphotype *zignodianum* (D'ORBIGNY): LRh3F5, LRh4F8, LRh5F3, LRh15F3 Grigore Collection in GIR. Preda's specimen (inv. 16aMPN) in Collection of MPN - originates from red nodular limestones – Ghilcoş outcrop.

Table 8. Measurements of *Holcophylloceras mediterraneum* (NEUMAYR, 1871) specimens.
Tabel 8. Măsurători ale exemplarelor de *Holcophylloceras mediterraneum* (NEUMAYR, 1871).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype (morphotype *mediterraneum*)	107	-	107	14	56	32	0.13	0.52	0.30	0.57
LRh2F6	50	50	43	6	22	~12	0.14	0.51	0.28	0.54
LRh31F1	75	62	75	9	39	~19	0.12	0.52	0.25	0.49
Morphotype *zignodianum*	95	-	95	9.5	48	32	0.10	0.51	0.34	0.67
Preda 16aMPN specimen	34	27	34	7	17	9	0.20	0.50	0.26	0.53
LRh3F5	39	23	34	5	18	10	0.15	0.53	0.29	0.55
LRh4F8	35	35	35	4.5	18	~11	0.13	0.51	0.31	0.61
LRh5F3	39	39	34	4.5	18	>11	0.13	0.53	0.32	0.61
LRh15F3	32	32	29	5	14.5	8.5	0.17	0.50	0.29	0.59

I take in consideration Joly's (1976, p. 243-249) observations, which put the *H. zignodianum* (D'ORBIGNY, 1847) in the *H. mediterraneum* species, as its microconch.

Remarks: only LRh31F1, LRh3F5 and 16aMPN preserve partially the living chamber, while the others are phragmocons small in size except the first. Most of them present 5 to 6 constrictions/whorl, with *H. zignodianum* particularities in shape and only LRh31F1 and LRh2F6 (Pl. 2, Fig. 6) respect Neumayr's features.

Occurrence: Lower Kimmeridgian – Platynota/Strombecki interval in Ghilcoş (E, F and probably W profiles) outcrops; Oxfordian /Lower Kimmeridgian in Italy, France, Germany, Austria, Hungary, Poland, Russia and Egypt.

Subfamily Ptychophylloceratinae COLLIGNON, 1955
Genus *Sowerbyceras* PARONA & BONARELLI, 1895
Sowerbyceras tortisulcatum (D'ORBIGNY, 1840)
Pl. 2, Figs. 1; 3

1840 *Ammonites tortisulcatus*-D'ORBIGNY; p. 161
1849 *Ammonites tortisulcatus* D'ORBIGNY-D'ORBIGNY; p. 506; Pl. 189
1871 *Phylloceras tortisulcatus* D'ORBIGNY-NEUMAYR; p. 344; Pl. 17, Fig. 10
1878 *Phylloceras tortisulcatus* D'ORBIGNY–HERBICH; p. 145; Pl. 3, Figs. 3a-b
1974 *Sowerbyceras tortisulcatum* (D'ORBIGNY)-BARBULESCU; p. 127; Pl. 6, Figs. 22; 23
non 1973 *Sowerbyceras tortisulcatum* (D'ORBIGNY)–PREDA; Pl. 4, Figs. 6; 7 (= *Sowerbyceras silenum*)
1979 *Sowerbyceras tortisulcatum* (D'ORBIGNY)-SAPUNOV; p. 35; Pl. 4, Figs. 2a-b

Material: LRh42A10, LRh43E1, LRh44B5, LRh45F, LRh46F7, LRh47A10, LRh48A, LRh49F7 Grigore Collection in GIR. Herbich's specimens: Collection of UBB - the figured ones originate from nodular limestones of Ghilcoş outcrop; about the others we haven't details.

Table 9. Measurements of *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1840) specimens.
Tabel 9. Măsurători ale exemplarelor de *Sowerbyceras tortisulcatum* (D'ORBIGNY, 1840).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	88	-	88	23	38	28	0.26	0.43	0.32	0.74
Herbich specimen	75	-	75	14	35	38	0.19	0.47	0.51	1.08
LRh42A10	64	42	60	11	30	26	0.18	0.50	0.43	0.87
LRh43E1	64	40	61	11	29	27	0.18	0.48	0.44	0.93
LRh44B5	~55	-	~55	12	~27	25	0.22	0.49	0.45	0.92
LRh45F	56	-	56	10.5	26	29	0.19	0.46	0.52	1.11
LRh46F7	~54	-	~54	~9.5	~26	25	0.18	0.48	0.46	0.96
LRh47A10	70	-	70	13	34	29	0.19	0.41	0.41	0.85
LRh48A10	56	-	56	8	28	24	0.24	0.50	0.43	0.86
LRh49F7	>73	54	64	13	30	>24	0.20	0.47	0.37	0.80

Remarks: only three specimens preserve a small part from the living chamber, while the others are phragmocones. Some of them have a narrow umbilicus and larger section than the holotype because they are deformed.

Occurrence: Kimmeridgian - Platynota/Acanthicum interval in Ghilcoş (A, F, B profiles) and Ciofronca outcrops; Oxfordian /Lower Kimmeridgian in France, Switzerland, Italy and Bulgaria.

Sowerbyceras silenum (FONTANNES, 1876)
Pl. 2, Figs. 5, 8, 10

1876 *Phylloceras tortisulcatus* D'ORBIGNY-GEMMELLARO; p. 49; Pl. 10, Figs. 1a-b
*1876 *Ammonites* (*Phylloceras*) *silenus*-FONTANNES; p. 33; Pl. 5, Fig. 2
1973 *Phylloceras tortisulcatus* D'ORBIGNY–PREDA; Pl. 4, Figs. 6; 7
1986 *Sowerbyceras silenum* (FONTANNES)-SARTI; p. 485
1993 *Sowerbyceras silenum* (FONTANNES)-SARTI; p. 52; Pl. 1, Figs. 1a-b

Material: LRh23F1, LRh51F3, LRh52F5, LRh53E3, LRh54F4, LRh55F7, LRh56F1, LRh57F5, LRh58F1, LRh59F4, LRh60E1, LRh61F6, LRh62E1, LRh63F1, LRh64F6, LRh65E1, LRh66F1, LRh67G1, LRh68G1, LRh69T1.0, LRh80W1, LRh82W1 Grigore Collection in GIR. Preda's specimens: Collection of MPN (inv. 16bMPN / Fig. 7) originates from red nodular limestones; other from grey nodular limestones – both from Ghilcoş outcrops.

Remarks: my specimens are of different dimensions but not exceeding 65 mm (Table 10); only few of them partially preserve the living chamber. In this population it is observed a decrease with the size of constrictions number, which is in juvenile stage. Preda's specimen (Pl. 2, Fig. 8) presented as P. *tortisulcatum* presents the features of this species, with more oval section and narrow umbilicus.

Table 10. Measurements of *Sowerbyceras silenum* (FONTANNES, 1876) specimens.
Tabel 10. Măsurători ale exemplarelor de *Sowerbyceras silenum* (FONTANNES, 1876).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	63	-	63	14	31	26	0.23	0.49	0.41	0.84
Preda 16bMPN specimen	36	-	36	9	17	15	0.25	0.47	0.42	0.88
LRh51F3	63	-	63	14.5	29	›25	0.22	0.46	0.40	0.86
LRh52F5	49	-	41	9	21	19	0.22	0.51	0.46	0.90
LRh53E3	61	-	61	13	29	›28	0.21	0.47	0.47	0.96
LRh54F4	57	42	57	8	31	27	0.14	0.54	0.47	0.87
LRh55F7	49	46	46	9	25	23	0.20	0.54	0.50	0.92
LRh56F1	42	-	42	9	21	17	0.21	0.50	0.40	0.81
LRh57F5	37	-	37	7	19	17	0.19	0.51	0.46	0.89
LRh58F1	38	-	38	7	20	17	0.18	0.53	0.45	0.85
LRh59F4	43	35	35	8	17	17	0.23	0.49	0.48	1
LRh60E1	36	-	36	6	19	18	0.17	0.53	0.50	0.95
LRh61F6	34	28	34	7	17	13	0.21	0.50	0.38	0.76
LRh62E1	22	-	22	4.5	11	10	0.20	0.50	0.45	0.91
LRh63F1	41	-	41	13	17	16	0.32	0.41	0.39	0.94
LRh64F6	29	-	29	6	14	14	0.21	0.48	0.48	1
LRh65E1	26	-	26	4.5	14	11	0.17	0.54	0.42	0.78
LRh66F1	24	-	20	4.5	11	10	0.22	0.55	0.50	0.91
LRh67G1	33	-	33	6	17	14	0.18	0.51	0.42	0.82
LRh68G1	31	-	29	6	14	13	0.21	0.48	0.45	0.93
LRh69T1,0	32	-	30	5.5	16	13	0.18	0.53	0.43	0.81
LRh80W1	41	-	41	9	18	16	0.22	0.44	0.39	0.89
LRh82W1	28	-	28	6	13	11	0.21	0.72	0.39	0.85

Occurrence: Lower Kimmeridgian – Platynota/Divisum interval in Ghilcoş outcrops (W, T, G, F, E profiles); Lower Kimmeridgian in Italy, France, Switzerland, Bulgaria.

Sowerbyceras loryi loryi (MUNIER CHALMAS, 1875) emended SARTI, 1993
Pl. 2, Figs. 7; 9

1875 *Sowerbyceras Loryi*-MUNIER-CHALMAS în HEBERT; p. 388
1877 *Ammonites* (*Phylloceras*) *Loryi* MUNIER-CHALMAS-FAVRE; p. 19; Pl. 1, Fig. 14
1973 *Phylloceras* (*Calliphylloceras*) *zignodianum* D'ORBIGNY-PREDA; Pl. 2, Fig. 3
1993 *Sowerbyceras loryi* morfa *loryi* (MUNIER CHALMAS)-SARTI; p. 54; Pl. 1, Figs. 3; 4

Material: LRh29K6, LRh30K7, LRh50J, LRh70T6.0, LRh71D3, LRh72T1.0, LRh73T1.0 Grigore Collection in GIR. Preda's specimen: inv. 25MPN in Collection of MPN; originates from red nodular limestones of Ghilcoş (F1).

Table 11. Measurements of *Sowerbyceras loryi loryi* (MUNIER CHALMAS, 1875) specimens.
Tabel 11. Măsurători ale exemplarelor de *Sowerbyceras loryi loryi* (MUNIER CHALMAS, 1875).

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Sarti specimen (Fig.4)	64	41	64	11	32	29	0.17	0.50	0.45	0.85
Preda 25MPN specimen	54	-	54	9	25	22	0.17	0.46	0.41	0.88
LRh29K6	53	-	53	11	26	21	0.21	0.49	0.40	0.81
LRh30K7	41	-	33	6.5	18	15	0.20	0.56	0.45	0.83
LRh50J	55	32	49	10	23	›18	0.20	0.47	›0.37	›0.78
LRh70T6.0	35	-	28	5	15	13	0.18	0.54	0.46	0.87
LRh71D3	31	-	31	6	16	›10	0.19	0.52	›0.32	›0.62
LRh72T1,0	32	-	30	5	15	13	0.17	0.50	0.43	0.87
LRh73T1,0	24	-	22	4	11	9.5	0.18	0.50	0.43	0.86

Remarks: all the specimens are of a small or medium size and only LRh50J preserves partially the living chamber. Preda's specimen is better preserved (Pl. 2, Fig. 9) but presents a more narrow section than Sarti's one[2].

Occurrence: Upper Kimmeridgian in Ghilcoş outcrops (K, T, D, J profiles); Kimmeridgian (Divisum/Beckeri interval) in Bulgaria, Italy, Switzerland, France.

Sowerbyceras loryi pseudosilenum SARTI, 1993
Pl. 2, Fig. 2

1993 *Sowerbyceras loryi* morphotyp *pseudosilenum*-SARTI; p. 55; Pl. 1, Fig. 2.

Material: LRh32B15, LRh33B13, LRh34K32, LRh35B13, LRh36D23, LRh77D29, LRh79K23, LRh81K27 Grigore Collection in GIR.

Table 12. Measurements of *Sowerbyceras loryi pseudosilenum* SARTI, 1993 specimens.
Tabel 12. Măsurători ale exemplarelor de *Sowerbyceras loryi pseudosilenum* SARTI, 1993.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	58	-	58	13	27	-	0.22	0.46	-	-
Paratype	48	-	48	10	22.5	18.5	0.21	0.47	0.39	0.82
LRh32B15	54	-	~54	8	30	›12	0.15	0.56	›0.22	›0.40
LRh33B13	32	-	~32	4	19	›7	0.13	0.59	›0.22	›0.37
LRh34K32	57	-	~57	7	34	›11	0.12	0.60	›0.19	›0.32
LRh35B13	75	-	~75	14	37	›11	0.19	0.49	›0.15	›0.30
LRh36D23	46	-	~44	6	25	›10	0.14	0.57	›0.23	›0.40
LRh77D29	58	-	~58	9	41	›13	0.15	0.71	›0.22	›0.32
LRh79K23	33	27	33	6	16	15	0.18	0.48	0.45	0.94
LRh81K27	42	-	42	9	20	›4	0.21	0.48	›0.09	›0.20

Remarks: LRh79K23 specimen is the only well preserved one; the others are deformed (flattened) providing from marls. All present the features of this species, with a projected ventral groove and bourrelet.

Occurrence: Upper Kimmeridgian - Eudoxus/Beckeri in Ghilcoş outcrops (K, B, D profiles); Beckeri Zone in Italy.

Genus *Ptychophylloceras* SPATH, 1927

Ptychophylloceras ptychoicum (QUENSTEDT, 1845)

1845 *Ammonites ptychoicum*-QUENSTEDT; p. 219; Pl. 17, Figs. 12a-c
1871 *Phylloceras ptychoicum* (QUENSTEDT)-NEUMAYR; p. 326; Pl. 16, Fig. 10
1973 *Phylloceras* (*Ptychophylloceras*) *ptychoicum* (QUENSTEDT)-PREDA; Pl. 3, Fig. 3
1976 *Ptychophylloceras ptychoicum* (QUENSTEDT)-JOLY; p. 287; Pl. 34, Fig. 4
1979 *Ptychophylloceras ptychoicum* (QUENSTEDT)-SAPUNOV; p. 33; Pl. 3, Figs. 6a-b; Pl. 4, Fig. 3
1986 *Ptychophylloceras ptychoicum* (QUENSTEDT)-SARTI; p. 486

Material: LRh11K36, LRh12K32 Grigore Collection in GIR. Preda's specimen: Collection of PLB; it originates from yellow sandstones – upper layers (= maybe levels through K30 – K40) – Ghilcoş outcrop (F1).

Remarks: Preda's specimen represents only a fragment from a whorl in a silty sample, which preserves some of the specific ornamental bourrelets. LRh11K36 specimen is almost similar, with more prominent bourrelets; LRh12K32 is a juvenile with three thin and flexuous constrictions and bourrelets on the ventral side.

Occurrence: Lower Tithonian – Hybonotum Zone in Ghilcoş outcrop (K profile); Tithonian from Europe (Italy, France, Switzerland, Germany, Poland, Bulgaria, Czech Republic), India, Crimea, Algeria, Madagascar.

ACKNOWLEDGMENTS

I would like to thanks to Professor Ioan Bucur and Ass. Mirela Popa from "Babeş Bolyai" University - Cluj Napoca (Palaeontology Department) for helping me with the material from Neumayr and Herbich collections. Sincere thanks to Conf. Sorin Baciu for helping me with the material of Preda Collection from Natural Science Museum of Piatra Neamţ.

Part of this study was financially supported by National Centre for Projects Management (CNMP) in the GEOBIOHAS Project (31-059 CTR/2007).

REFERENCES

AVRAM E. 1976. *Les fossiles du flysch eocretacee et des calcaires tithoniques des hautes vallées de la Doftana du Tirlung* (*Carpates Orientales*). Mémoires de l'Institut de Géologie. Bucarest. **24**: 5-74.

BARBULESCU A. 1974. Stratigrafia Jurasicului din vestul Dobrogei centrale. Editura Academiei R. S. R. Bucureşti. 173 pp.

BENEKE E. W. 1866. *Über Trias und Jura in den Südalpen*. Geognostisch-Paläontologische Beiträge. München. **1**: 5-203.

CANAVARI M. 1896. *La fauna degli strati con Aspidoceras acanthicum di Monte Serra presso Camerino. I, (Anthozoa, Cephalopoda: Phylloceras, Lytoceras, Oppelia, Eurynoticeras n. gen., Holcostephanus*). Palaeontographica Italica. Pisa. **2**: 25-52.

CATULLO T. A. 1847. *Prodromo di Geognosia Paleozoica delle Alpi Venete*. Memoria Societa Italiana di Scienze. Modena. 158 pp.

CHRIST H. A. 1960. *Beitrage zur Stratigraphie und Palaontologie des malm von Westsizilien*. Schweizerischen Paläontologischen Abhandlungen. Tübingen. **77**: 1-141.

DUMORTIER E. & FONTANNES F. 1876. *Description des ammonites de la zone a Ammonites tenuilobatus de Crussol (Ardèche) et de quelques autres fossiles jurassiques nouveaux au peu connus*. Mémoires de l'Académies de Lyon. Classe Sciences. Lyon. **21**: 187-342.

FAVRE E. 1877. *La zone a Ammonites acanthicus dans les Alpes de la Suisse et de la Savoie*. Memoire Société Paléontologique Suisse. Geneve. **4**(3): 1-113.

FAVRE E. 1879. *Description des Fossilles des couches tithoniques des Alpes Fribourgeoises.* Memoire Société Paléontologique Suisse. Geneve. **6**. 74 pp.

FONTANNES F. 1879. *Description des Ammonites des calcaires du Chateau de Crussol (Ardeche).* Travaux Universitaire. Lyon: 1-122.

GEMMELLARO G. G. 1872. *Sopra i cefalopodi della zona con Aspidoceras acanthicum Opp.sp. di Burgilamuni presso Favara, provincia di Girgenti.* Giornale Scienze Naturale Economia. Palermo. **8**: 30-52.

GEMMELLARO G. G. 1876. *Sugli strati con Aspidoceras acanthicum di Sicilia e sui loro cefalopodi.* Atti Ricerca Accademica Nazionale Lincei. Memorie Cl. Scientifiche Fisica Matematiche Naturali. Roma. **2**(3): 239-243.

GEMMELLARO G. G. 1877. *Sopra alcuni fossili della zona con Posidonomia alpina Grass di Sicilia.* Giornale Scienze Natuturali Economia. Palermo. **12**: 51-80.

GRIGORE D. 2002. *Formaţiunea cu Acanthicum din regiunea Lacu Roşu (Msv. Hăghimaş-Carpaţii Orientali) - posibil hipostratotip al limitei Kimmeridgian – Tithonic. Stratigrafie. Paleontologie.* Teză doctorat. Universitatea „Alexandru Ioan Cuza". Iaşi. 347 pp.

GRIGORE D. 2011. *Kimmeridgian – Lower Tithonian Ammonite Assemblages from Ghilcoş – Hăghimaş Massif (Eastern Carpathians – Romania).* Acta Palaeontologica Romaniae. Editura Presa Universitară Clujeană. Cluj Napoca. **7**: 177-189.

GRIGORE D., LAZĂR IULIANA, GRASU C., GHEUCA I., CIOBANETE D., CONSTANTINESCU A., MARCU IULIA. 2009. *Paleontological sites from Cheile Bicazului – Hăşmaş National Park.* Oltenia. Studii şi comunicari. Ştiinţele Naturii. Muzeul Olteniei Craiova. **25**: 355-365.

HEBERT M. 1875. *Observation sur le travail de M. Pillet relatif à la colline de Lémenc.* Bulletine Societé Géologique de la France. Paris. **3**(3): 387-388.

HERBICH F. 1878. *Das szeclerland mit Berucksichtigung der Angrezenden Landesteile.* Mittheilungen aus dem Jahrbuch der Koeniglichen Ungarischen geologischen Reichsanstalt in Budapest. **5**: 19-363.

JOLY B. 1976. *Les Phylloceratidae malgaches au Jurassique. Généralités sur les Phylloceratidae et quelques Juraphillitidae.* Documentes Laboratoire Géologique. Faculté Science. Lyon. **67**. 471 pp.

NEUMAYR M. 1871. *Jura Studien. Die Phylloceraten des Dogger und Malm.* Jahrbuch der Kaiserlich-Koniglichen Geologischen Reichsanstalt. Wien. **21**: 297-378.

NEUMAYR M. 1873. *Die Fauna der Schichten mit Aspidoceras acanthicum.* Abhandlungen der kaiserliche und koenigliche geologische Reichsanstalt. Wien. **5**(6): 141-257.

OPPEL A. 1865. *Die tithonische Etage.* Zeitschrift der Deutschen Geologischen Gesellschaft. Berlin. **17**: 535-558.

ORBIGNY A. 1840-1849. *Paléontologie francaise. Terrains jurassiques. I. Cephalopodes.* Masson et Cie. Paris: 1-642.

PREDA I. 1973. *Variaţiile de facies şi biostratigrafia Jurasicului superior din Munţii Hăghimaş.* Studii şi Cercetări de Geologie, Geografie şi Biologie. Seria Geologie, Geografie. Muzeul de Ştiinţe Naturale Piatra Neamţ. **2**: 11-21.

QUENSTEDT F. A. 1845–1849. *Petrefactenkunde Deutschlands. I. Die Cephalopoden.* Petrefactenkunde Deutschlands. (Ed.) L. F. Fues. Tübingen. **3**(1). 580 pp.

SAPUNOV I. G. 1979. *Les fossiles de Bulgarie. III. 3. Jurassique supérieur. Ammonoidea.* Academia Bulgaria Science. Sofia: 1-263.

SARTI C. 1986. *Fauna e biostratigrafia del Rosso Ammonitico del Trentino centrale (Kimmeridgiano-Titoniano).* Bolletino Societa Paleontologica Italiana. Modena. **23**: 473-514.

SARTI C. 1993. *Il Kimmeridgiano delle Prealpi Veneto-Trentine: fauna e biostratigrafia.* Memorie Museo Civico Scienze Naturale. Sezione Scienze della Terra. Verona. **5**: 1-144.

ZEISS A. 1994. *Neue Ammonitenfunde aus dem oberen Malm Suddeutschlands.* Abhandlungen der Geologischen Bundes-Anstalt. Wien. **50**: 509-528.

ZITTEL K. A. 1868. *Die Cephalopoden der Stramberg Schichten.* Mitteilungen der Staatssammlung Bayerischen für Paläontologie und historischen Geologie. München. **2**(1): 1-188.

Grigore Dan
Geological Institute of Romania,
Caransebeş 1st, Bucharest 012721,
Romania, tel. 021-2128952,
E-mail: dan1_grigore@yahoo.com

Received: March 28, 2011
Accepted: August 20, 2011

PLATE 1 / PLANŞA 1

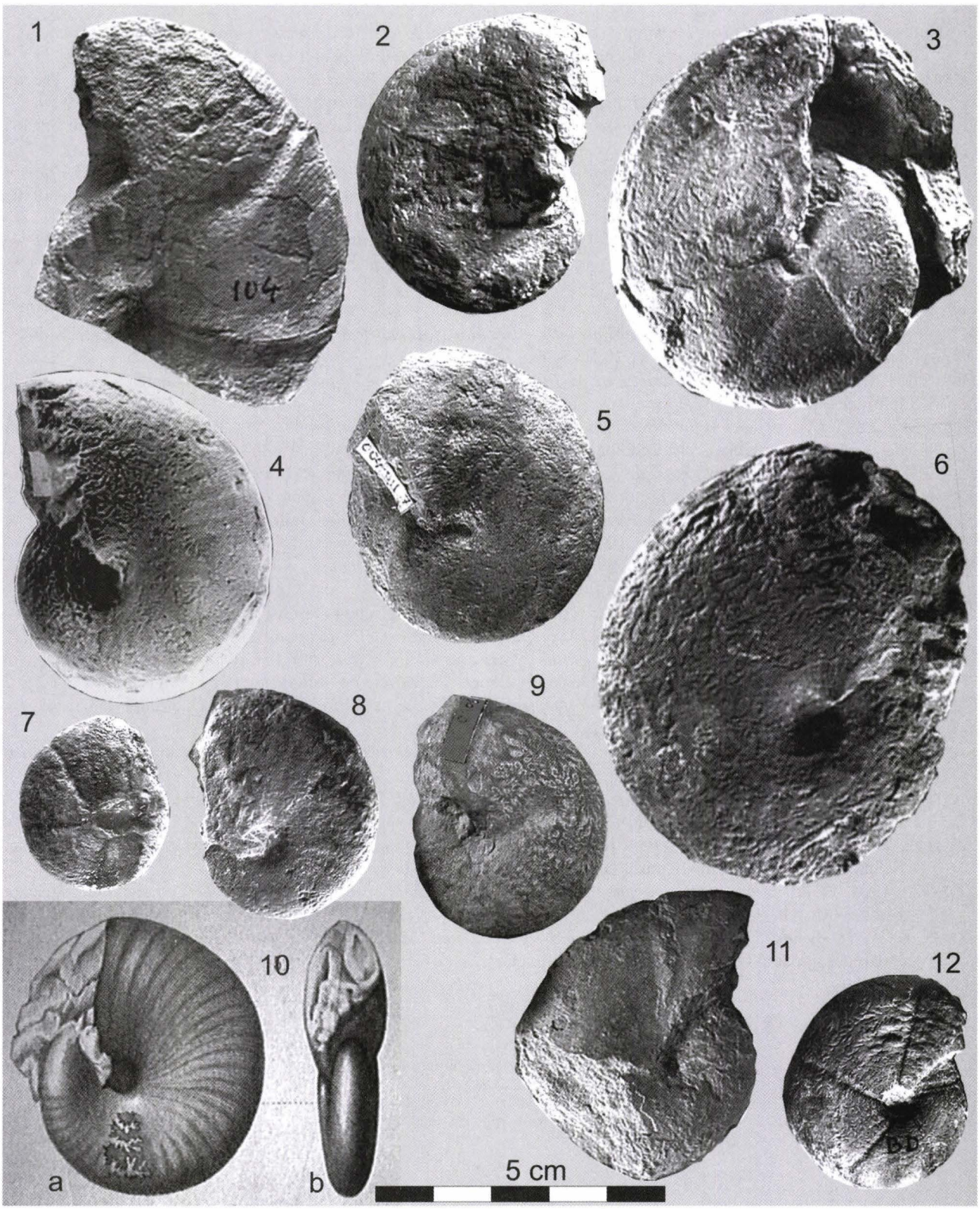


PLATE 2 / PLANŞA 2

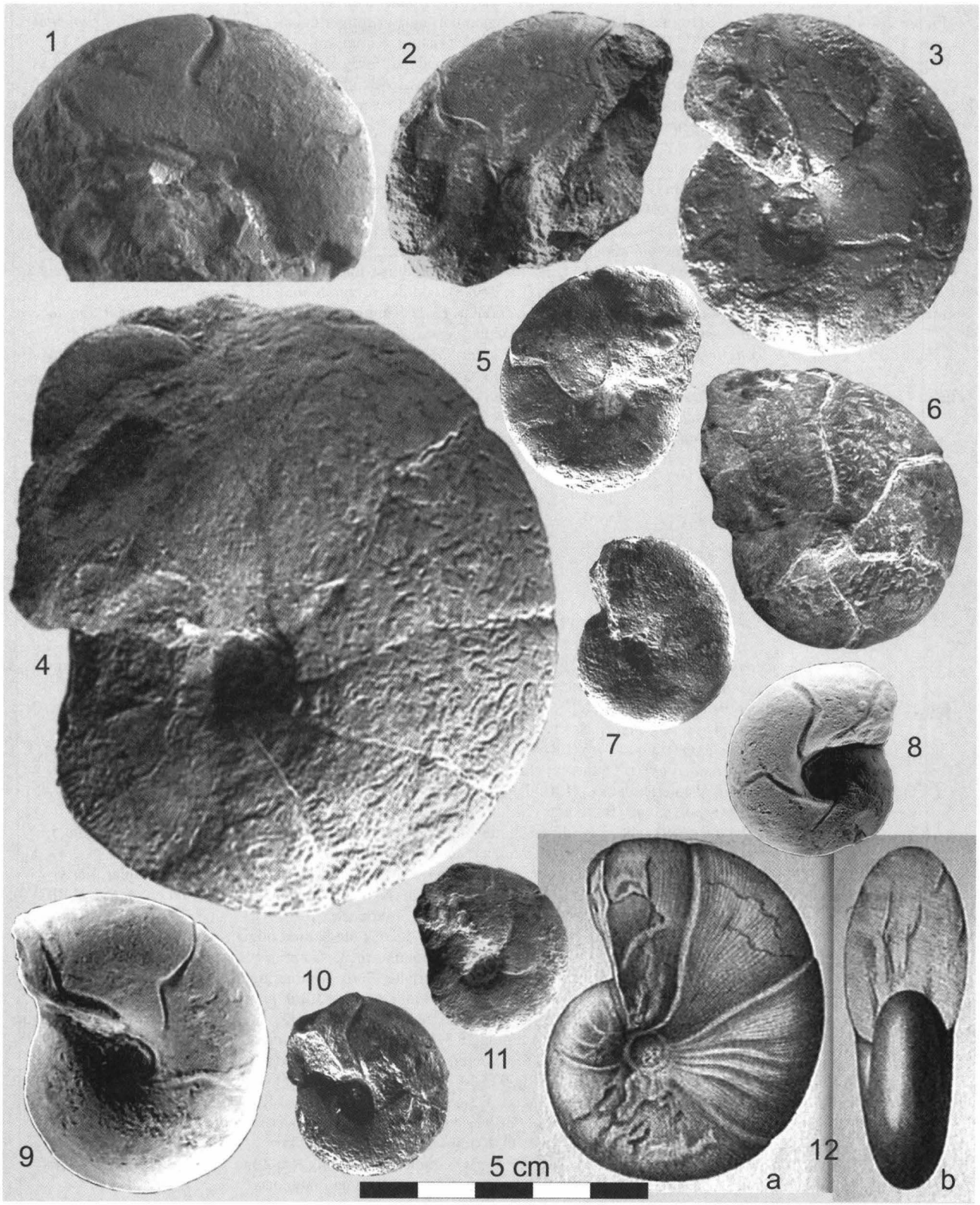


PLATE 1 / PLANŞA 1

Figure 1. *Calliphylloceras benacense* (CATULLO) (LRh74B15); grey sandstones, Late Kimmeridgian-Beckeri Zone. / Figura 1. *Calliphylloceras benacense* (CATULLO) (LRh74B15); gresii cenuşii, Kimm. sup.-Zona Beckeri.
Figure 2. *Phylloceras isotypum* BENECKE (LRh13G7); reddish nodular, Early Kimmeridgian. / Figura 2. *Phylloceras isotypum* BENECKE (LRh13G7); nodular vişiniu, Kimm. inf.
Figure 3. *Calliphylloceras benacense* (CATULLO) (LRh75A3); green nodular, Early Kimmeridgian-Divisum Zone. / Figura 3. *Calliphylloceras benacense* (CATULLO) (LRh75A3); nodular verzui, Kimm. inf.-Zona Divisum.
Figure 4. *Phylloceras consanguineum* GEMMELLARO (Preda **14a MPN**); grey limestone, Late Kimmeridgian. / Figura 4. *Phylloceras consanguineum* GEMMELLARO (Preda **14a MPN**); calcare cenuşii, Kimm. sup.
Figure 5. *Phylloceras saxonicum* NEUMAYR (LRh40F2); green nodular, Early Kimmeridgian-Platynota Zone. / Figura 5. *Phylloceras saxonicum* NEUMAYR (LRh40F2); nodular verzui, Kimm. inf.-Zona Platynota.
Figure 6. *Phylloceras saxonicum* NEUMAYR (LRh41J); green nodular, Early Kimmeridgian-Divisum Zone. / Figura 6. *Phylloceras saxonicum* NEUMAYR (LRh41J); nodular verzui, Kimm. inf.-Zona Divisum.
Figure 7. *Calliphylloceras manfredi* (OPPEL) (LRh26W); reddish nodular, Early Kimmeridgian-Strombecki Zone. / Figura 7. *Calliphylloceras manfredi* (OPPEL) (LRh26W); nodular pătat, Kimm. inf.-Zona Strombecki.
Figure 8. *Phylloceras consanguineum* GEMMELLARO (LRh84A3); green nodular, Early Kimmeridgian-Divisum Zone. / Figura 8. *Phylloceras consanguineum* GEMMELLARO (LRh84A3); nodular verzui, Kimm. inf.-Zona Divisum.
Figure 9. *Phylloceras saxonicum* NEUMAYR (LRh83E1); green nodular, Early Kimmeridgian-Platynota Zone. / Figura 9. *Phylloceras saxonicum* NEUMAYR (LRh83E1); nodular verzui, Kimm. inf.-Zona Platynota.
Figure 10. *"Pylloceras leptoptychum"* HERBICH (**2053 UC**); green sandstones, Late Kimmeridgian. / Figura 10. *„Pylloceras leptoptychum"* HERBICH (**2053 UC**); gresii verzui, Kimm. sup.
Figure 11. *Calliphylloceras kochi* (OPPEL) (LRh1K38); sandstones, Early Tithonian-Semiforme Zone. / Figura 11. *Calliphylloceras kochi* (OPPEL) (LRh1K38); gresii, Tith. inf.-Zona Semiforme.
Figure 12. *Calliphylloceras manfredi* (OPPEL) (LRh23F6); green nodular, Early Kimmeridgian-Strombecki Zone. / Figura 12. *Calliphylloceras manfredi* (OPPEL) (LRh23F6); nodular verzui, Kimm. inf.-Zona Strombecki.

PLATE 2 / PLANŞA 2

Figure 1. *Sowerbyceras tortisulcatum* (D'ORBIGNY) (LRh43E1); green nodular, Early Kimmeridgian-Platynota Zone. / Figura 1. *Sowerbyceras tortisulcatum* (D'ORBIGNY) (LRh43E1); nodular verzui, Kimm. inf.-Zona Platynota.
Figure 2. *Sowerbyceras loryi pseudosilenum* SARTI (LRh32B15); grey limestone, Late Kimmeridgian-Beckeri Zone. / Figura 2. *Sowerbyceras loryi pseudosilenum* SARTI (LRh32B15); calcare cenuşii, Kimm. sup.-Zona Beckeri.
Figure 3. *Sowerbyceras tortisulcatum* (D'ORBIGNY) (LRh42A10); green nodular, Early Kimmeridgian-Divisum Zone. / Figura 3. *Sowerbyceras tortisulcatum* (D'ORBIGNY) (LRh42A10); nodular verzui, Kimm. inf.-Zona Divisum;
Figure 4 *Holcophylloceras polyolcum* (BENECKE) (LRh8E1); green nodular, Early Kimmeridgian-Platynota Zone. / Figura 4. *Holcophylloceras polyolcum* (BENECKE) (LRh8E1); nodular verzui, Kimm. inf.-Zona Platynota;
Figure 5 *Sowerbyceras silenum* (FONTANNES) (LRh56F1); green nodular, Early Kimmeridgian-Platynota Zone. / Figura 5. *Sowerbyceras silenum* (FONTANNES) (LRh56F1); nodular verzui, Kimm. inf.-Zona Platynota.
Figure 6. *Holcophylloceras mediterraneum* (NEUMAYR) mf. *mediterraneum* NEUMAYR (LRh2F6); green nodular, Early Kimmeridgian-Strombecki Zone / Figura 6. *Holcophylloceras mediterraneum* (NEUMAYR) mf. *mediterraneum* NEUMAYR (LRh2F6); nodular verzui, Kimm. inf.-Zona Strombecki.
Figure 7. *Sowerbyceras loryi loryi* (MUNIER CHALMAS) (LRh70T6,0); red nodular, Late Kimmeridgian-Acanthicum Zone. / Figura 7. *Sowerbyceras loryi loryi* (MUNIER CHALMAS) (LRh70T6,0); nodular roşu, Kimm. sup.-Zona Acanthicum.
Figure 8. *Sowerbyceras silenum* (FONTANNES) (Preda **16b MPN**); red nodular, Early Kimmeridgian-Platynota Zone. / Figura 8. *Sowerbyceras silenum* (FONTANNES) (Preda **16b MPN**); nodular roşu, Kimm. inf.-Zona Platynota.
Figure 9. *Sowerbyceras loryi loryi* (MUNIER CHALMAS) (Preda **25 MPN**); red nodular, Early Kimmeridgian-Platynota Zone. / Figura 9. *Sowerbyceras loryi loryi* (MUNIER CHALMAS) (Preda **25 MPN**); nodular roşu, Kimm. inf.-Zona Platynota.
Figure 10. *Sowerbyceras silenum* (FONTANNES) (LRh69T1,0); red nodular, Early Kimmeridgian-Platynota Zone. / Figura 10. *Sowerbyceras silenum* (FONTANNES) (LRh69T1,0); nodular roşu, Kimm. inf.-Zona Platynota.
Figure 11. *Holcophylloceras mediterraneum* (NEUMAYR) mf. *zignodianum* D'ORBIGNY (LRh15F3); green nodular, Early Kimmeridgian-Strombecki Zone. / Figura 11. *Holcophylloceras mediterraneum* (NEUMAYR) mf. *zignodianum* D'ORBIGNY (LRh15F3); nodular verzui, Kimm. inf.-Zona Strombecki.
Figure 12. *"Phylloceras bekasense"* HERBICH; red nodular, Early Kimmeridgian-Platynota Zone. / Figura 12. *„Phylloceras bekasense"* HERBICH; nodular roşu, Kimm. inf.-Zona Platynota.

Eotrigonodon (OSTEICHTHYES, PLECTOGNATII) IN RICHARD BRECKNER'S COLLECTION (NATURAL HISTORY MUSEUM SIBIU)

CIOBANU Rodica

Abstract. The current paper presents data on the pharyngeal teeth belonging to the genus *Eotrigonodon* WEILER 1929, which are part of the Palaeontological Collection Richard Breckner. I described six teeth collected from the actual protected palaeontological area "Eocene limestones from Turnu Roşu (Porceşti)". The teeth are extremely flattened laterally and display a sickle shape. They miss their roots, but where small roots fragments are preserved, we may notice the difference in thickness between the crown and the root and vertical folds. Taking into account that the species determinations were made on the basis of oral teeth and their association with pharyngeal teeth (sickle type) with these, the latter were determined in the same way as they were found within the same deposits. At the same time, this type of tooth can be both pharyngeal and incisor. Due to these features and to the fact they were found in Eocene deposits, they may be considered as belonging to *Eotrigonodon* genus. Only three teeth were specifically assigned to *Eotrigonodon serratus* WEILLER 1929. This study is the first one to mention the genus and species at Turnu Roşu (Porceşti).

Keywords: pharyngeal teeth, eotrigonodontides fish, Eocene, limestone, Turnu Roşu (Sibiu).

Rezumat. *Eotrigonodon* (Osteichthyes, Plectognatii) în colecţia Richard Breckner (Muzeul de Istorie Naturală Sibiu). În această lucrare sunt descrişi dinţi faringieni ce aparţin genului *Eotrigonodon* WEILER 1929, ce fac parte din Colecţia paleontologică Richard Breckner. Cei 6 dinţi faringieni descrişi provin din aria paleontologică protejată „Calcarele eocene de la Turnu Roşu (Porceşti)". Dinţii se caracterizează prin accentuata aplatizare laterală şi morfologia care imita forma de seceră. Rădăcinile lipsesc, dar la dinţii la care se păstrează o mică parte din ele se poate observa diferenţa de grosime dintre coroană şi rădăcină şi slabe riduri verticale. Determinările la nivel de specie s-au bazat pe dinţi orali, iar asocierea dinţilor faringieni (de tip cârlig) cu aceştia, în cadrul aceloraşi depozite, a atras şi asupra celor din urmă aceeaşi determinare. Acest tip de dinţi poate fi atât de tip faringian cât şi incisiv. Caracteristicile morfologice şi faptul că s-au găsit în depozite Eocene, conduc la atribuirea acestor dinţi genului *Eotrigonodon*. Doar 3 dinţi s-au determinat la nivel de specie, ca aparţinând la *Eotrigonodon serratus* WEILLER 1929. Acest studiu este prima menţionare a genului şi speciei în calcarele eocene de la Turnu Roşu (Porceşti).

Cuvinte cheie: dinţi faringieni, peşti eotrigonodontizi, eocen, calcare, Turnu Roşu (Sibiu).

INTRODUCTION

On the initiative of several Saxon Naturalist intellectuals, in a time when the Transylvanian as well as European Naturalism were crossing a period of fast development, on May 4th 1849, in Sibiu (Hermannstadt), after two years of meetings which took the form of book clubs, The Transylvanian Society of Natural Sciences (*Siebenbürghische Verein für Naturwissenschaften zu Hermannstadt*) was founded. The founders wanted to be part of a society that gathered people with a common passion for nature, who could also share their findings with their community, and not only as well as to educate the young generation in the spirit of knowledge and protecting nature.

The first collections of plants, animals, fossils, minerals and rocks were established even before the establishment of the Society (during the period when its founders were members of the Transylvanian Cultural Society – *Siebenbürghische Landeskunde*) (SCHNEIDER & STAMP, 1970). Due to the rapid growth of the collections, storage places changed constantly, however, after considerable financial efforts, the Natural History Museum was opened on May 12, 1895 as a public institution and main office for the Society. After more than 160 years from the creation of the Society, the palaeontological collection alone gathers 57,000 items.

In the present paper, I render the pharyngeal teeth belonging to the *Eotriogonodon* genus, part of Richard Breckner's palaeontological collection. For the majority of palaeontologists and naturalists, Richard Breckner is virtually unknown. However, his collection of fish teeth (mostly shark teeth) is unique in Romania. The fact that about 30% of this collection (teeth) is determined at the level of knowledge of the early 20th century speaks to Breckner's knowledge in the field.

Considering the importance of the collection for the Romanian fish palaeontology and not only, I have provided a few brief details regarding Richard Breckner (1900-1979). According to "*Schriftsteller - Lexicon der Siebenbürger Deutschen*" / "*The Lexicon of Transylvanian Saxon personalities*" (1998), Breckner was an art critic, journalist, literary secretary for the theatre and writer. Between 1933-1938 he was a freelancer making a living by writing scientific papers on the fossil collection from Transylvania. Neither the dictionary, nor any other reference talks about these papers or where the results of this scientific activity were published. Breckner's name appears more and more often between 1937–1946 in the Society paper, in the "Vereinsnachrichten" column, being praised for his work in registering and cataloguing the collections (even re-determining the shark teeth), especially palaeontological ones. In 1938 Richard Binder, the chairman of the Society, congratulated the diligence and competence of the one who "worked for years on the Porceşti tertiary fossils especially shark teeth". However there are no details concerning his writing activity or his collection, which we believe was created during this period (CIOBANU, 2007).

Breckner's palaeontological collection, part of which are the teeth in subject, contains fossils (molluscs) from Lăpugiu de Sus and 5,000 fish teeth, mainly shark, from Turnu Roşu (Porceşti). This collection was acquired in 1954 (according to the museum archives) from Heinrich Breckner (relative of Richard Breckner), a printer from Sibiu.

MATERIAL AND METHODS

The paper describes 6 pharyngeal teeth collected from the palaeontological reserve "Calcarele eocene de la Turnu Roşu (Porceşti)" (*The Eocene limestone from Turnu Roşu (Porceşti)*). The richness of the Eocene fauna recovered in these deposits, from which the fish teeth were also collected, caught scientists' attention as early as the beginning of the 19th century, when several valuable systematic research studies were conducted. The majority of the palaeontological studies referring to this peculiar area were conducted by the members of the Society.

These limestone rich in fauna are part of the Eocene shallow marine sequences lying north of the Făgăraş Mountains, on the southern border of the Transylvanian Basin. Around Turnu Roşu, the Eocene formations emerge like a limestone "patch" area on the northwestern ending of the Făgăraş metamorphic rocks (Fig. 1).

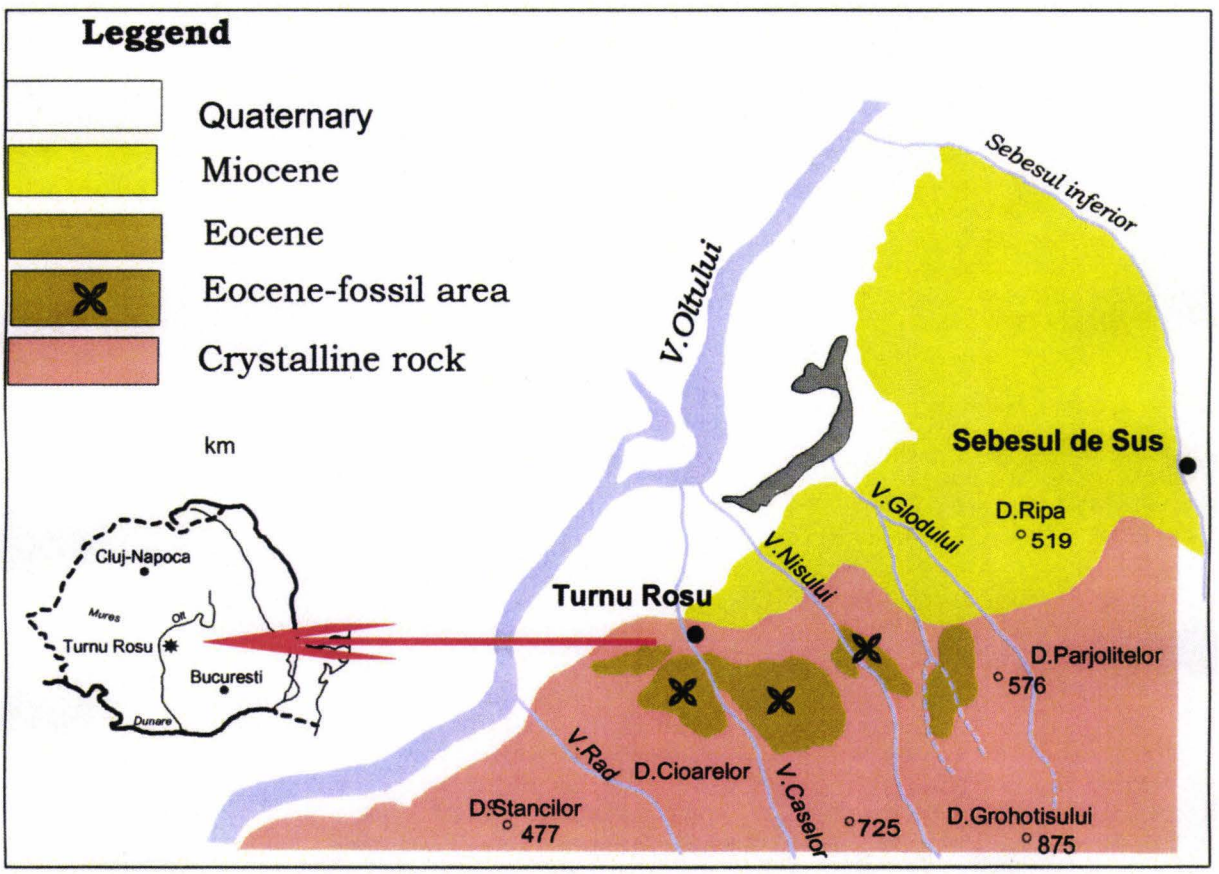


Figure 1. Geological map of Turnu Roşu palaeontological reserve (adapted after TĂTĂRÂM, 1970).
Figura 1. Harta geologică a rezervaţiei paleontologice Turnu Roşu (adaptat după TĂTĂRÂM, 1970).

The latest concept regarding the stratigraphy of the limestone of Turnu Roşu belongs to MÉSZÁROŞ (1996) who defined the Turnu Roşu Group, including the Valea Nişului and Valea Muntelui formations (both Eocene). The faunal analysis underlined the existence of almost all Eocene groups and up to recently they represent the largest deposits bearing isolated fish teeth. Environment reconstructions based on correlation between fossil fauna and recent representatives of the species, indicate warm tropical-subtropical waters, rich in oxygen and biota (MÉSZÁROS & IANOLIU, 1972, 1973; BUCUR & IANOLIU, 1987; CIOBANU, 2006).

I believe the fish teeth were collected from Valea Nişului and Valea Caselor (Fig. 2), the fossiliferous outcrops of the natural reserve. Unfortunately, neither Neugeboren[1], nor other collectors – in our case Breckner – ever mentioned the exact location where they collected the fossils from. The sample of fish teeth collected in the last few decades is very small compared to the old collections.

[1] Ludwig Johann Neugeboren (1806-1887) carried out the first micro paleontological studies in Transylvania and published the first scientific study related to the Eocene sharks from Turnu Roşu.

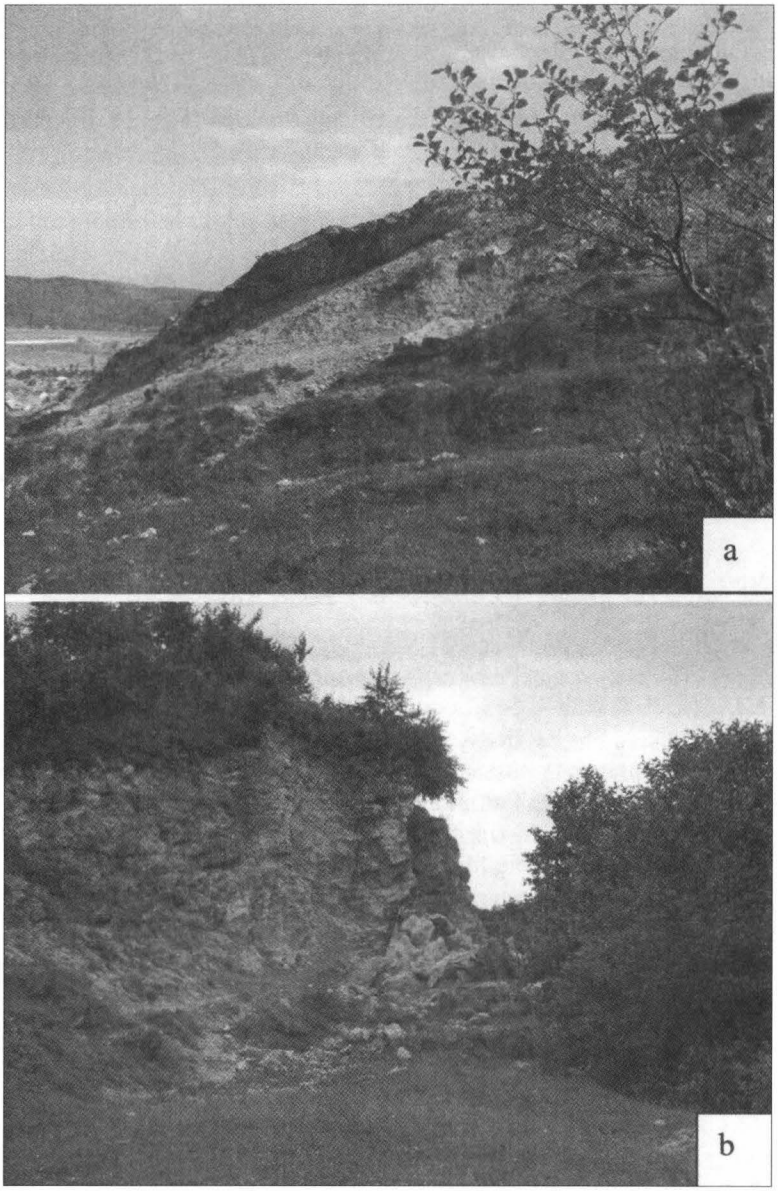


Figure 2. Eocene Limestone from Turnu Roşu (a-V.Caselor; b-V. Nişului).
Figura 2. Calcarul eocen de la Turnu Roşu (a-Valea Caselor; b-V. Nişului).

Systematic Palaeontology

Class Osteichthyes
Subclass Actinopterygii
Infraclass Teleostei
Order Tetraodontiformes *(*Plectognathi*)*
Suborder Balistoidei
Family Eotrigonodontidae WHITE 1935

The Eotrigonodontidae includes three genera: *Stephanodus* DAMES 1883, *Kankatodus* KUMAR & LOYAL 1987 and *Eotrigonodon* WEILLER 1929. The single European Paleogene genus is *Eotrigonodon*, the other ones being older (Cretaceous).

***Eotrigonodon serratus* WEILER, 1929**

(figs. 5, 6, 7, 8, 9; Pl.1)

Material: 3 pharyngeal teeth from R. Breckner's collection (PaBr 34145, PaBr 34146, PaBr 34147, PaBr 34148, PaBr 34150).

Origin: Eocene limestone from Turnu Roşu (Porceşti)

***Eotrigonodon* sp.**

(fig. 10; pl.1)

Material: 3 pharyngeal teeth from R. Breckner's collection (PaBr 34149)

Origin: Eocene limestone from Turnu Roşu (Porceşti)

Description

The teeth are laterally compressed, very flat and sickle-shaped (Fig. 4). Their roots are missing. However, for the ones that still keep a small root fragment one can observe the difference in thickness between the crown and root. The contact border between root and crown exposes fine vertical wrinkles (Fig. 3). Based on these features and the stratigraphy of the locality where they are originating from – Eocene – they can be related to *Eotrigonodon*.

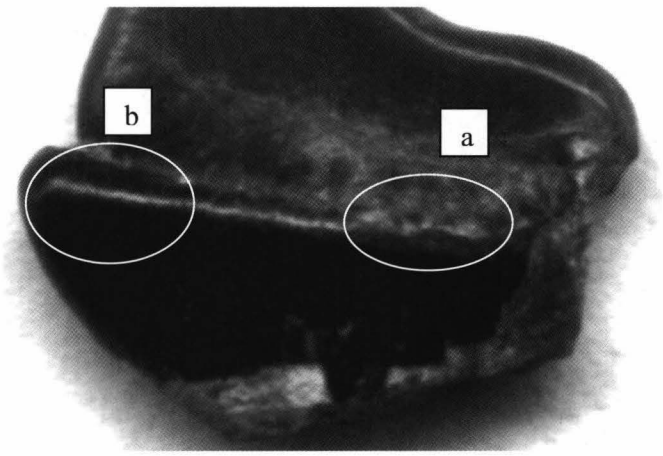


Figure 3. Details of tooth Pa 34.149 (a-vertical folds; b-root crown border).
Figura 3. Detalii ale dintelui Pa 34.149 (a-cute verticale; b-marginea rădăcinii coroanei).

As for these last teeth, although they have the general characteristics of this genus, they have a few easily recognizable differences. Therefore, the teeth in figs. 6, 9, and 10 have their apex of the cusp more upright than sickle shaped. The tooth in fig. 10 has its apex worn out, most probably due to wear and the teeth in figs. 7, 8, and 10 have vertical folds in the lower part; at the tooth in fig. 5 the border between the root and the cusp of the tooth is done through a strip with vertical folds. The tooth from fig. 9 resembles to the one illustrated by LERICHE (1906), figs. 66-69 like *Eotrigonodon serratus*; it is possible for the apex to have been worn away by wear. The teeth of figs. 5, 6, 7 resemble those illustrated by Priem (1897) in pl. VII like *Ancistrodon armatus*.

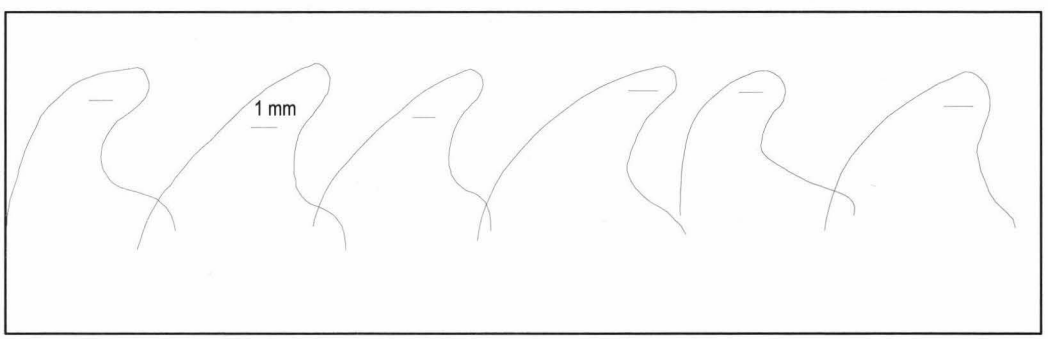


Figure 4. The sickle-shaped shown by the teeth (left to right - tooth 1 - 6).
Figura 4. Forma curbată a dinților (de la stânga la dreapta - dintele 1 - 6).

DISCUSSIONS

In Romania, the first reports on "*Eotrigonodon*" teeth in the Paleogene of Transylvania belong to KOCH (1900), who mentioned the presence of *Capitodus* in the limestone formations of Cluj in a faunal list. However, it is possible that this fossil could be rather an *Eotrigonodon* tooth. CODREA et al. (1997) includes also *Eotrigonodon* in the list of fossil fish originating from the Cluj Limestone. For Romania, the first mention related to their presence in Cretaceous deposits was done by DICA et al. (1998), referring to a single oral tooth of *Eotrigonodon serratus*.

In a complex study on palaeoenvironment reconstruction based on fish assemblages, DICA (2005) mentioned 6 pharyngeal teeth and 1 oral tooth belonging to *Eotrigonodon serratus*, in the Cluj Limestone (Priabonian), Racoți Sandstone and Jibou. From all 6 of the pharyngeal teeth, only a single one was however, described.

The genera and species assignations are faced with major odds, as all discoveries refer exclusively to isolated teeth and not to a full dental apparatus. The already discovered teeth expose wide morphological variability but also present similarities between related taxa. Furthermore, there is a lack of comparative material.

These flat sickle-shaped teeth drew researchers' interest and were described in references since the second half of the 19th century. These teeth were found in deposits ranging from Cretaceous until the end of the Eocene. This

morphological teeth type which expose differences in size between the crown and root were firstly described by Gervais (1848-1852) under different names: *Sargus, Armatus, Serratus* etc.

DAMES (1883) named these teeth as "*Ancistrodon*" type; he thoroughly described them and he even distinguished several different species out of the *Sargus* genera defined by Gervais. He firstly showed that "*Ancistrodon*" teeth are actinopterygian pharyngeal teeth and belong to the sparid type. In the majority of the papers from the 19th / 20th centuries boundary, the flat sickle-shaped teeth were called "*Ancistrodon*". As Dames observed that they are similar to pharyngeal teeth belonging to other species from the same Tetraodontiformes / Plectognathi order, like *Balistes*, he doubted the previous findings of some forerunners.

PRIEM (1897) specified that he sometimes found flat sickle isolated teeth with the root wider compared to the base of the crown in "Senonian" and Lower Cenozoic formations. He described and illustrated an *Ancistrodon armatus* pharyngeal tooth from the Mont Mokattam Eocene limestone. Priem presents the opinions of authors who have described up to then the "Ancistrodon" teeth. Although he agreed with Dames' findings, he showed at the end of the paper, that Woodward, who published a catalogue in 1895, considered that the teeth published under the name of *Ancistrodon* teeth are actually pycnodontes prehensile incisors. He concludes his paper stating that the teeth in question are actually pycnodontes prehensile teeth.

LERICHE (1906, 1910), studying the Eocene fish fauna in Belgium, noted that the *Ancistrodon* teeth resemble the *Balistes* incisors – both genera have claw shaped teeth which fish used for nibbling coral biohermes. Therefore, Leriche believes that at least for the Eocene in Belgium, *Ancistrodon armatus* are not pharyngeal teeth but real incisors and wear is the main cause for the different teeth morphologies.

WEILLER (1929) defined for the first time the *Eotrigonodon* genera based on several *Trigonodon* oral teeth with dentate oral edge, considering that this species occupies an intermediary position between *Stephanodus* (Cretaceous) and *Trigonodon* (Cenozoic). The author believes that "*Ancistrodon*" teeth which accompany incisors do not belong to the *Trigonodon* species but they resemble more the Sparidae and Sciaenidae teeth.

CASIER (1946) seems to agree with Weiller; and he further explains the relative richness of pharyngeal teeth found in the strata by explaining that each individual has 4 incisors (2 superior and 2 inferior) and 70 pharyngeal teeth. Casier also explains the morphological variations though wear.[2] Furthermore, he mentions that these teeth have a sideway flattened root, slightly thicker than the crown and with folds.

In the majority of works, the *Eotrigonodon* species are based on oral teeth. The association between oral and pharyngeal teeth is highly uncertain because it is based on the fact that they are just found together in the same sediments.

There were also other authors who described the "claw" or "sickle" shaped teeth as belonging to different species of pycnodontes. So, WOODWARD (1901) noted that some pycnodontes have teeth claw type in their gill chamber, whereas BELL (1986) described the "claw" teeth type as being gill teeth belonging to the pycnodont *Hadrodus* genera.

CASE (1994) considers that the "*Ancistrodon*" teeth are "nibbling" teeth for eating at coral biohermes. They are situated alongside each other in groups of 4 to 6 flattened teeth in the symphyseal regions of the jaws.

KRIWET (2005) realized a complex study of pycnodonte fish skulls and mentioned that during his research he observed several "Ancistrodon" gill teeth at Cretaceous pycnodontes. Furthermore, there are present species of Balistes and Pyconodontes whose sickle-shaped, laterally compressed teeth are placed on the edge of the lower and upper jaw.

The taxonomy of fossil eotrigonodontid fish is hard to deal with because of the lack of complete fossilized jaws, recent comparative material and references. There are debates on their taxonomy, but the majority of authors catalogue them as *Plectognathi* – marine tropical fish with unified teeth to form a beak which they use for nibbling at coral biohermes. Regarding the taxonomy of fossil genera *Eotrigonodon*, ROMER (1966) considers them as belonging to the Trigonodontidae family and their present systematic position was established by CASIER (1966).

CONCLUSIONS

Considering that the species of eotrigonodontid fish had oral teeth and that they are associated to the same rocks with the claw shaped pharyngeal teeth, the same identification may result. Although this type of teeth can be either pharyngeal, or incisors, their systematic classification and identification can be uncertain. According to the available references, I believe these teeth can be referred to as *Eotrigonodon*. Considering that the teeth in figs. 5, 6, 7, 8 are sickle shaped and are similar to the teeth described in the references, I came to the conclusion that they belong to *serratus* species. As the teeth in fig. 6 display a sharper end (they resemble the ones presented by Kumar, Loyal in 1987), I believe they resemble the ones presented within *indicus* species. However, these species were described only for Late Cretaceous–Paleocene of India. As a result, I consider that this tooth can be assigned only up to genus level.

Eotrigonodontids, the extinct puffer fish are analogous to the present day tetraodontidae. They are characterized by four oral teeth in the jaws, the pair in each jaw forming a parrot like beak. Besides the oral teeth, they have a number of pharyngeal teeth. *Tetraodon cutcutia* the common puffer fish is native to the fresh and slightly brackish waters of India. In India eotrigonodontids are much more abundant in the Lower Eocene marine sequence also in the Middle Eocene in brackish to fresh water transitional sequence (KUMAR & LOYAL, 1987).

[2] LERICHE (1906) explains as well the large variability of morphologies due to wear.

ACKNOWLEDGEMENTS

I would like to thank Prof. Dr. Vlad Codrea (Babeş-Bolyai University, Cluj-Napoca) for improvements on text and for his useful advice.

Figure 5. *Eotrigonodon serratus* WEILLER 1929.

Figure 6. *Eotrigonodon serratus* WEILLER 1929.

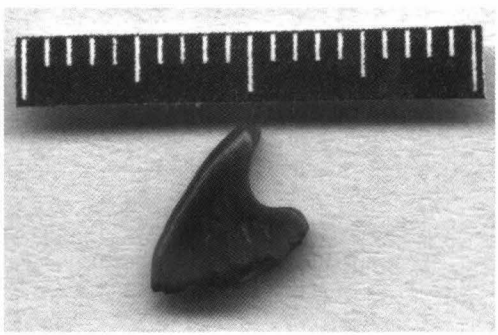


Figure 7. *Eotrigonodon serratus* WEILLER 1929.

Figure 8. *Eotrigonodon serratus* WEILLER 1929.

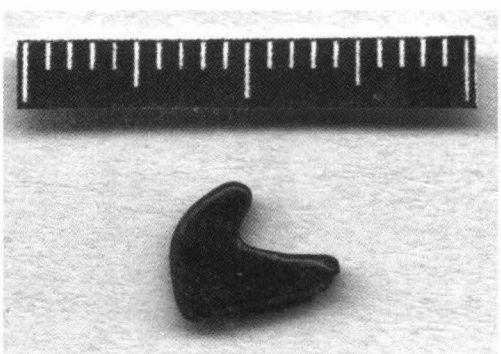


Figure 9. *Eotrigonodon serratus* WEILLER, 1929.

Figure 10. *Eotrigonodon* sp.

REFERENCES

BUCUR I. & IANOLIU C. 1987. *L' Éocéne de Turnu Roşu – Porceşti. Contributions sur les algues calcaires.* The Eocene from the Transylvanian Basin: 37-42.

CASE G. R. & WEST R. M. 1991. *Geology and Paleontology of the Eocene Drazinda Shale Member of the Khirthar Formation, central Western Pakistan, Part II Late Eocene fishes*. Tertiary Research. Leiden. **12**(3-4): 105-120.

CASE G. R. 1994. *Fossil fish remains from the Late Paleocene Tuscahoma and Early Eocene bashi formations of Meridian, Lauderdale County, Mississippi, Part II. Teleosteans*. Palaeontographica Abt. A. Stuttgart. **230**(4-6): 139-153.

CASIER E. 1946. *La faune ichtyologique de l'Ypresien de la Belgique*. Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Bruxelles: 104, 267.

CASIER E. 1966. *Faune ichtyologique du London Clay*. Trustes of the British Museum Natural History. London: 496.

CIOBANU RODICA. 2006. *Evaluări paleoecologice pe baza patrimoniului muzeal. Studiu de caz: Turnu Roşu*. Marisia. Studii şi materiale, Târgu Mureş. **28**: 69-79.

CIOBANU RODICA. 2007. *Naturalists from Sibiu and their fossil collections at the Natural History Museum from Sibiu.* Acta Musei Devensis, Sargetia, Series Scientia naturae. Deva. **20**: 27-42.

CODREA V., VREMIR M., DICA E. P. 1997. *Calcarul de Cluj de la Someş-Dig (Cluj-Napoca): Semnificaţii paleoambientale şi impactul activităţilor antropice asupra aflorimentului.* Studii şi cercetări. Bistriţa. **3**: 31-39.

DAMES W. 1883. *Ueber Ancistrodon Debey.* Zeitschrift der deutschen geologischen Gesellschaft: 655-670, pl. XX.

DICA E. P. 2005. *Studii paleoambientale in formatiumile paleogene din NV-ul Depresiunii Transilvaniei pe baza asociaţiilor ihtiologice. Raport de cercetare, grant TD 24/15.* In: Revista de Politică a Ştiinţei şi Scientometrie, Numar Special: 1-77.

DICA E. P., BUCUR I., STRUSIEVICZ R. O. 1998. *First mention of Eotrigonodon (Osteichthyes, Plectognathi) in Lower Cretaceous deposits from Romania.* Studia Universitatis „Babeş-Bolyai", Geologia. Cluj-Napoca. **42**(2): 65-69.

GERVAIS P. 1848-1852. *Zoologie et Paléontologie françaises. II. Poissons fossils.* Paris: 2, 5.

HERMAN J. 1972. *Contribution á la connaissance de la faune ichthyologique des phosphates du Maroc.* Annales de la Société Géologique. Bruxelles. **95**: 271-284.

KOCH A. 1900. *Systematishe Ubersicht der fossilen wirbeltierreste der Lander der Ungarischen Krone.* Magyar Orvosok és Természettudományi – vizsg. Vándorgy Munká, Budapest. **30**: 526-560.

KRIWET J. 2005. *A comprehensive study of the skull and dentition of pycnodont fishes.* Zitteliana, München. **45**: 135-188.

KUMAR K. & LOYAL R. S. 1987. *Eocene ichthyofauna from the Subathu Formation, Nort-Western, Himalaya.* India Journal of the Palaeontological Society of India. **32**: 60-84, 3 pls., 102 figs.

LERICHE M. 1906. *Contribution a l'étude des poissons fossiles du nord de la France et des régions voisines.* Mémoires de la Société Géologique du Nord, Lille. **5**: 264-265.

LERICHE M. 1910. *Les poissons tertiares de la Belgique. III. Les poissones Oligocenes,* Mémoires de Musée Royal de L' Histoire Naturelle de Belgique. Bruxelles. **5**(2): 229-363.

MÉSZÁZROS N. 1996. *Stratigrafia regiunii Turnu Roşu – Porceşti.* Convergenţe transilvane. Sibiu. **4**: 42-45.

MESZAZROS N. & IANOLIU C. 1971. *Contribuţii la problema limitei Eocen-Oligocen în regiunea Turnu-Roşu.* Studii şi comunicări, Muzeul Brukenthal. Ştiinţele Naturii. Sibiu. **16**: 29-33 (in Romanian).

MÉSZÁZROS N. & IANOLIU C. 1972. *Macrofauna eocenă de la Turnu Roşu (I).* Studii şi comunicări, Muzeul Brukenthal. Ştiinţele Naturii. Sibiu. **17**: 21-31.

MÉSZÁZROS N. & IANOLIU C. 1973. *Macrofauna eocenă de la Turnu Roşu (II).* Studii şi comunicări. Ştiinţele Naturii. Muzeul Brukenthal. Sibiu. **18**: 13-23.

PRIEM F. 1897. *Sur les poissons de l'Eocène du Mont Montkatam (Egypte).* Bulletin de la Société Géologique de France. 3-ème série. Paris. **25**: 220-223.

RANA R. S., KUMAR K., SINGH H. 2004. *Vertebrate fauna from the subsurface Cambay Shale (Lower Eocene), Vastan Lignite Mine, Gujarat, India.* Research Communications, Current Science. **87**(12): 1726-1733.

ROMER A. S. 1966. *Vertebrate Paleontology.* (3rd ed.), Univ. Chicago Press. Chicago. 468 pp.

SCHNEIDER E. & STAMP H. M. 1970. *Societatea Ardeleană de Ştiinţe Naturale din Sibiu în cei 100 de ani de existenţă.* Studii şi comunicări, Ştiinţe Naturale. Sibiu. **15**: 36-67.

TĂTĂRÂM NIŢA. 1970. *Eocenul din sud-vestul Transilvaniei consideraţii biostratigrafice şi paleogeografice.* Analele Universităţii Bucureşti. Seria geologie. **19**: 119-141.

WEILLER W. 1929. *Die mitel und obereocaene Fishfauna Agypteus mit besonderer Beriicksichtigung der teleostomi.* Abh. der Bayerischen Akademie der Wissenchaften Mathematisch-Naturwiss Abteilung, Muenchen. 57 pp.

WOODWARD A. S. 1917. *Catalogue of the Fossil Fishes in the British Museum (Natural History).* London. **4**: 636 pp.

Ciobanu Rodica
Brukenthal National Museum
The Museum of Natural History Sibiu
Str. Cetăţii 1, 550337 Sibiu, România
E-mail: ciobanu.rodica@brukethalmuseum.ro

Received: March 20, 2011
Accepted: August 11, 2011

CONSIDERATIONS ON HUMAN EVOLUTION AND ON SPECIES ORIGIN CENTERS

CORNEANU C. Gabriel, CORNEANU Mihaela

Abstract. This paper is structured on two mainly sections. In the first section there are presented actual knowledge about the origin of the modern humans, based on the mtDNA and genomic DNA analysis at the fossil and actual human species. In the second section, based on the classical centres of the domesticated of the plants, elaborated by Nikolai I. Vavilov, as well as on the paleontological data, Earth surface evolution, on the migration and dispersion on the Earth surface of the human populations, etc., there are discussed the domestically centres of some culture plants and animals. It is evidenced the importance of the human populations presence and their migration, the size of the considered area, as well as the genetic diversity of the biological sources. It is discussed the domestication process of some culture plants as: wheat, rye, barley, potato, grape vine, garlic, black cumin, etc., as well as of some animals as horse, dog, chicken. The implication of many factors in the domestication process is evidently. A special attention can be accorded to some areas as Fertile Crescent and Central Asiatic Centre. Thus in Central Asiatic Centre there were present, in the same time in the same area, three human genotypes: *Homo sapiens, Homo neanderthalensis*, and *Homo denisovan*. In this region (Central Asia Centre) numerous culture plants (common wheat, peas, lentil, horse bean, onion, garlic, spinach, carrot, grape, apple, pear, a/o), as well as animals (dog, horse, chicken, etc.) were domesticated. The analysis of the species from the culture centres origin, on basis of recent data of genetics and molecular biology, as well as on palaeontology and civilization history data, will permit the thoroughly into the knowledge of life evolution.

Keywords: Human evolution, plants, origin centres.

Rezumat. Consideraţii asupra evoluţiei omului şi a centrelor de origină a speciilor. Această lucrare este structurată pe două părţi principale. În prima secţiune, sunt prezentate cunoştinţele actuale despre originea omului modern, bazată pe analiza mtDNA şi DNA genomic de la speciile fosile şi specia umană actuală. În cea de a doua secţiune, bazat pe centrele clasice de domesticire ale plantelor, elaborate de Nikolai I. Vavilov, precum şi pe datele paleontologice, evoluţia suprafeţei uscatului pe planeta Terra, migraţia şi dispersia populaţiilor umane pe suprafaţa acesteia ş.a., sunt discutate centrele de domesticire ale unor plante de cultură şi animale. Este subliniată importanţa prezenţei populaţiilor umane şi migraţia lor, mărimea arealului considerat, precum şi diversitatea genetică a surselor biologice. Este discutat procesul de domesticire a unor plante de cultură ca: grâu, secară, orz, cartof, negrilică, usturoi, viţă de vie ş.a., precum şi a unor animale precum calul, câinele, găina. Implicarea mai multor factori în procesul de domesticire este evidentă. O atenţie deosebită trebuie acordată unor regiuni precum Fertile Crescent (Cornul Abundenţei) şi Centrul Asia Centrală. Astfel, în centrul Asiei Centrale, au fost prezente în acelaşi timp şi pe aceeaşi suprafaţă trei genotipuri umane: *Homo sapiens, H. neanderthalensis* şi *H. denisovan.* În această regiune (Centrul Asia Centrală), au fost domesticite numeroase plante de cultură (grâul comun, mazărea, lintea, fasolea, usturoiul, ceapa, spanacul, morcovul, strugurii, mărul, părul ş.a.), precum şi animale (câinele, calul, găina ş.a.). Analiza speciilor din centrele de origină, pe baza datelor recente de genetică şi biologie moleculară, a datelor de paleontologie şi istorie a civilizaţiilor, va permite adâncirea cunoaşterii în evoluţia vieţii.

Cuvinte cheie: evoluţia omului, plante, centre de origină.

HOMO EVOLUTION

After the human genome deciphering (DENNIS & GALLANGHER, 2001) the researches of molecular genetics were amplified. Also, there were performed researches meant to decipher the genome from other species, the studies about the phylogenetic relations between species and their evolution. Many studies focussed on the human genome and its evolution, the best incisive being effected by Pääbo Svante and his co-workers. According to the classical conception, the human ancestors lived in Africa (Fig. 1), where the first shape of humanization was discovered.

20 million years ago, it took place the evolutive divergence between Hylobatidae and Hominidae, and 12 million years ago, the evolutive divergence between Pongidae and Hominidae. The first species of the *Homo* genus appeared 2.8 million years ago, and 2 million years ago, the first individuals of the *Homo* genus quitted Africa. The divergence process in the *Homo* genus began 1.8 million years ago.

The homo evolution probably began 8 million years ago, when the divergence between anthropoids and hominids occurred. The first ancestor of the *Homo* genus was probably *Sahelanthropus tchadensis* which lived in the Sahel region 7.2-6.8 million years ago (BRUNET, 2011). After a time, in Africa, it also lived *Ardipithecum kadaba* (5.9 million years) from which *Ardipithecum ramidus* descended (WHITE et al., 2009), a biped humanoid (4.5 million years ago). The ancestor of two fossil humanoids were discovered in the South of Africa: *Australopithecus anamensis* (4.5 million years ago), from which derived many *Paranthropus* species and *Homo habilis*. Related with *Australopithecus anamnesis*, it was *Kenyanthropus platyops* (3.5 million years ago) from which *Homo rudolfensis* derived (2.8 million years ago). *Homo habilis* constituted a nodal species, from which there were considered some evolution pathways. After Science & Vie (2010), *Homo habilis* (2.7 million years ago) was the ancestor of *Homo ergaster* (2 million years ago), which constituted a nodal species in human evolution. On one hand, it derived *Homo heidelbergensis* (living between 950,000 and 270,000 years) and *Homo sapiens*, 180,000 years ago. Also, from *Homo ergaster* as ancestor there derived two evolutive lines for the fossil humanoid species. On one part, it evaluated *Homo neanderthaslensis* (living between 450,000 and 30,000 years ago) and *Homo denisovan* (500,000-120,000 years ago). On the other line, it evaluated *Homo*

erectus (850,000-110,000 years ago) and *Homo floresiensis* (110.000-12.000). COPPENS (2011) proposed another evolution play. The first hominids were of African origin and are represented by *Homo habilis* and *Homo rudolfensis*. Theirs descendents were *Homo ergaster* and *Homo erectus*. From these, in other continents, there evolved other humanoid species. In Europe, it appeared and lived, *Homo heidelbergensis* (ancient Neanderthal) and *Homo neanderthalensis* (Fig. 2). In Asia, it is mentioned *Homo floresiensis*, *Homo denisovan*, and *Homo erectus soloensis* (Homo of Java).

The *Homo sapiens* migrated from Africa (Fig. 3), 100,000 years ago, in Mirror Asia and then in two directions: a part toward Europe (40,000-45,000 years) and another part in Southeast Asia (70,000 years) and in Central Asia (40,000 years). From Central Asia, they migrated in North America (15,000 year) through Behring site and then in South America (12,000 years). From South Asia, they migrated through Polynesia in Australia (50,000 years), other islands from the Pacific and New Zeeland (1,000 years). Thus, until 10,000 years ago, all continents were populated, except the islands from the Pacific Ocean. In their migration they contributed to the living organisms spread, an explanation for the existence of multiple centres of origin for some species.

Svante Pääbo incited by the unexpected, analysed the genome of *Homo nenderthalensis*, versus a genome from an actual *Homo sapiens sapiens*. The first researches were performed in 1997, being identified 1 Mb sequences of genomic DNA from *Homo neanderthaliensis*, from which 99.5 were identical with DNA genomic from actual *Homo sapiens sapiens* (KRINGS et al., 1997). Subsequent, PÄÄBO et al., (2008) obtained all the nuclear DNA extracted from a bone of *Homo neanderthalensis* (fossils from Croatia 38,000 years ago; Fig. 2). They established that 1 – 4 % from *Homo neanderthalensis* DNA is present also in human populations from Europe and Asia. The same DNA is absent at human African populations. They consider that *Homo sapiens* quitted Africa, migrated in Arabia and Middle Orient. In these areas he met *Homo neanderthalensis*, having a hybrid descend, spread in Europe and Asia, 100,000 – 50,000 years ago.

Homo floresiensis was discovered in Flores Islands (Indonesia), in 2003 (Fig. 4). Initially it was discovered a female skeleton, which lived 12,000 – 13,000 years ago, of about 1 m height, small head, of about 30 years old and 25 kg weight. Subsequently, there were discovered another 7 skeletons. They lived in a time period between 95,000 and 12,000 years ago. There were emitted many hypothesis about these humans: (a) an ancient human race; (b) a distinct human species; (c) a pathological shape of *Homo sapiens*; (d) a descend from *Homo erectus*. This island being in a tropical area, the DNA analysis is difficult.

Homo denisovan. In March 2010 in Denisova cave (Altai Krai, Russia), it was discovered a finger bone and tooth from a female juvenile human that lived 41,000 years ago, in a region also inhabited in the same time by Neanderthals and modern humans. The mtDNA analysis from Denisova human is distinct from mtDNA of Neanderthals and modern humans (KRAUSE & PÄÄBO, 2010). The analysis indicated that modern humans, Neanderthals and Denisova hominid, shared a common ancestor around 1 million years ago (KATSNELSON, 2010). Some studies suggest that modern humans coexist with Neanderthals in Europe, and the discovery raises the possibility that Neanderthals, modern Human and Denisova hominid may have co-existed. Probably the Denisova hominid resulted from a previously migration of the humans from Africa. The analysis of mtDNA extracted from a tooth of Denisova hominid, revealed different characteristics similar with to teeth of Homo erectus, indicating a divergence time about 7,500 years before. The estimated time of divergence between Denisovan and Neanderthals is 640,000 years ago, and between both these groups and modern Africans is 804,000 years ago. It was also analysed the DNA from Denisovan and the DNA from different actual human populations (Fig. 5). It was established that 4 – 6% from the DNA of Denisova hominid are present in human Melanesian population from Papua-New Guineas and Bougainville islands. The same DNA is not present in other 50 populations belonging to modern human. Probably the two species present a common ancestor, hawing an independent evolution, 200,000 years ago. Homo Denisovan was breed with ancestors of the Melanesian populations. Also, in this region it developed a rich centre of plant domestication under the action of the hominid populations from the three genotypes (common wheat, peas, lentil, horse bean, onion, garlic, spinach, carrot, grape, apple, pear, etc.).

Other situations. In the Qesem cave, situated near Tel Aviv (Israel), naturally closed 200,000 years ago, there were discovered eight teeth belonging to *Homo neanderthalensis* and *Homo sapiens*. They belong to some fossils with two distinct ages: (a) 300,000-400,000 years and (b) 200,000-300, 000 years. For explanation, there were emitted many hypothesis: (a) they belong to an archaic population from *Homo* genus; (b) fossils of *Homo neanderthalensis*, which evolved differently; (c) these teeth belong to a new human species; (d) *Homo sapiens* appeared more earlier, and thus his migration from Africa to Asia and Europe; (e) the origin sites of the human species is Middle Orient, not Africa.

THE SPECIES ORIGIN CENTRES

The species origin centres are geographical areas where the ancestors of the present domesticated species appeared. The process of speciation was present all over the Earth, in all geological eras. Thus, in the Miocene, *Buxus sempervirens* was a diploid species. Subsequently, it took place a spontaneous doubling of the chromosome number, and the actual tetraploid *Buxus sempervirens* species was formed (CORNEANU et al., 2004). The process of species diversity took place usually in natural conditions. In the case of domesticated species, the human collectivity acted and accelerated this process. Thus the classical "centre of genetic origin" of the domesticated genotypes, represent these

areas where the domesticated genotypes (plant and animals) appeared under action of human collectivities. These centres greatly influenced by human evolution and human spread at the Earth surface.

N. I. VAVILOV developed a theory on the centres of origin of cultivated plants (1961). The **Vavilov Center (Vavilov Center of Diversity)** is a region of the world considered to be an original centre for the domestication of plants (VAVILOV, 1961). VAVILOV established that the plants were domesticated in some regions, considered to be the centre of diversity. The **Vavilov centres** are regions where a high diversity of crop wild relatives can be found, representing the natural relatives of domesticated crop plants. After this conception, there appeared eight centres of origin of the domesticated plants (or centres of diversity; Fig. 6).

1) South Mexican and Central American Centre includes the southern sections of Mexico, Guatemala, Honduras, and Costa Rica. Domesticated: maize, common bean, cotton, cherry tomato, cacao, etc.

2) South American Centre 62 plants listed; three sub centres: (2) *Peruvian, Ecuadorean, Bolivian Centre* (potato, tomato, cotton, bean, tobacco, etc.); (2A) ***Chiloe Centre*** (Island near the coast of southern Chile; potato, strawberry); (2B) ***Brazilian-Paraguayan Centre*** (manioc, peanut, etc.).

3) Mediterranean Centre includes the borders of the Mediterranean Sea. 84 domesticated plants: durum wheat, emmer, oats, pea, rape, olive, cabbage, peppermint, black mustard, Baraka, etc.

4) Middle East includes the inner part of Asia Minor, Transcaucasia, Iran, and the highlands of Turkmenistan. 83 domesticated species: einkorn wheat, durum wheat, oats, pear, apple, cherry, alfalfa, lentil, lupine, etc.

5) Ethiopia includes Abyssinia, Eritrea, and part of Somaliland. 38 domesticated species: emmer, barley, sorghum, pearl millet, coffee, etc.

6) Central Asiatic Centre includes Northwest India (Punjab, Northwest Frontier Provinces, and Kashmir), Afghanistan, Tajikistan, Uzbekistan, and western Tian-Shan. 43 domesticated plants: common wheat, peas, lentil, sesame, cotton, onion, garlic, spinach, carrot, pear, grape, apple, etc. We consider, that this centre was the largest, as it included also South Siberia.

7) Indian Centre, with two sub centres: (7) **Indo-Burma:** Main Centre (Hindustan): it includes Assam and Burma, but not Northwest India, Punjab, nor Northwest Frontier Provinces. 117 domesticated plants: rice, pigeon pea, eggplant, cucumber, radish, yam, mango, orange, sugar, oil, fibre plants, stimulants, pepper, etc.; (7A) **Siam-Malaya-Java:** stat Indo-Malayan Centre: it includes Indo-China and the Malay Archipelago. 55 domesticated plants: banana, coconut palm, breadfruit, coconut palm, sugarcane, clove, nutmeg, etc.

8) Chinese Centre, 136 domesticated endemic plants: soybean, onion, cucumber, peach, walnut, apricot, etc.

The Fertile Crescent is a geographical region extended from actual Israel, Jordan, Lebanon, and western Syria into southeastern Turkey and along the Tigris and the Euphrates rivers into Iraq and Iran. In this region, 10,000 years ago, were meet the progenitors of actual cereal species, as wild wheat (*Triticum urartu*, *T. boeoticum*, *T. dicoccoides*, *Aegilops tauschii*), wild barley (*Hordeum spontaneous*) and wild rye *(Secale vavilovii*). The seeds of the wild species (and many others) were meeting in early archaeological sites of the region, and stratigraphic succession. On the actual knowledge, in Fertile Crescent the humans invented agriculture, this region being a genetic centre origin for many culture species (ÖZKAN et al., 2002). In this area, there were met earlier human species (Qesem cave with fossils of *Homo sapiens* with 400,000 years ago).

Triticum sp. (wheat). The first wheat grains dating from 11,000 BC, were found in the Fertile Crescent regions of the Near East. The Archaeological analysis indicates that the wild emmer was cultivated in southern Levant, being meet at Iraq ed-Dubb in northern Jordan dating back as far 9,600 BC (12, 13). The first wheat species were diploids, having 14 chromosomes, with genome AA (*Triticum monococcum*, einkorn) or BB (probably *Triticum searsii*, unknown wild wheat. 8,000 years ago, it took place spontaneous chromosome doubling resulting a tetraploid wheat (*Triticum turgidum*, wild emmer, 2n=28, AABB). Subsequently, hybridization with another diploid wheat species with DD genome (*Triticum tauschii*, or others) occurred, resulting the hexaploid wheat, *Triticum aestivum* (2n=42, AABBDD; Fig. 7).

The archaeological investigations suggest that the wheat was first grown in the Karacadag Mountains in southeastern Turkey. With exception of two grains from Iraq ed-Dubb, the domestication of einkorn took place near the Karacadan Mountain, in the Neolithic period, between 8,600 and 7,500 BC. The researches performed by other researchers in the same region point out that the domesticated emmer wheat was found in the earliest levels of Tell Aswad in the Damascus basin, near mount Hermon in Syria, 8,800 years BC (VAN ZEIST & BAKKER-HEERES, 1982). The wheat cultivation quickly spread in this part of the world: Cultivation in Fertile Crescent after about 8,500 BC; Greece, Cyprus, and India by 6,500 BC; Egypt shortly after 6,000 BC; the Danube plain by 5,500 BC; Germany and Spain by 5,000 BC; England and Scandinavia by 3,000 B.C; China, by 2,000 B.C.

Secale cereale L. (rye), in a wild state, was present in central and eastern Turkey, and in adjacent areas. The domesticated rye was discovered in some Neolithic sites in Turkey. The rye was virtually absent until the Bronze Age in Central Europe (1800-1500 B.C.; ZOHARY & HOPF, 2000). Archaeological arguments underlined the rye presence in the Antique Roman world, along the Rhine, the Danube and in the British Isles. After Pliny the Elder, rye "is a very poor food and only serves to avert starvation", and spelt is mixed into it "to mitigate its better taste, and even then is most unpleasant to the stomach". A controversial aspect is much earlier cultivation of rye, at the Epipalaeolithic site of Tell Abu Hureyra in the Euphrates valley of northern Syria, as well as its cultivation by the antic civilization from the Danube plain, the actual territory of Romania, 4,500-5,000 years BC.

Hordeum vulgare (barley). The origin of barley is debatable, possible originating in Egypt, Ethiopia, the Near East or Tibet. With certitude, barley was among the earliest cultivated plants, in the same period with wheat. The extended area for the barley origin can be due to its use and spread by human populations from the Neolithic period. In the Middle East, barley was grown prior to 10,000 BC. After other authors, barley was domesticated in western Asia before 7,000 BC. From this region, barley cultivation spread to northern Africa, moving along the Nile into Ethiopia, where it became one of the major cereals. It is used in the human and animal alimentation, as well as at the beer production.

Vitis vinifera L. (grape vine) is native to the Mediterranean region, central Europe, and southwestern Asia to northern Iran, from Morocco and Portugal, north to southern Germany. It is cultivated on every continent on the Earth, except Antarctica. The wild grape is *Vitis sylvestris* (or *Vitis vinifera* ssp. *sylvestris*), and the cultivated sorts belong to *Vitis vinifera* ssp. *vinifera*. As biological species, *Vitis vinifera* dated between 130 and 200 million years ago, while its utilisation by people started in the Neolithic period. The domestication of the grape vine took place about 3,500 - 3,000 BC, in southwest Asia, the South Caucasus (Armenia and Georgia), or the Western Black Sea (Bulgaria and Romania). In the northern Iran, there were discovered wine storage jars, of 7,000 years old. The cultivation of the domesticated grape vine, spread in the Old World, in pre-historic or early historic time. The first evidences of grape vine can be found in Gilgamesh, an ancient Sumerian text from the third millennium BC. We can also mention numerous evidences in the ancient world: Egypt, Greeks, Etruscan, Roman, Dacia, etc.

Nigella sativa L. (Baraka, black cumin, etc.), is a medicinal plant used since Antiquity. It is original from the Mediterranean area and Middle Orient. This hypothesis is underlined by the presence of other species belonging to this genus from this area (minimum 14 species with 25 genotypes). In addition, presently, it occurs an evolution and diversification in this genus, in the same area through geographical isolation. Thus the geographical isolation on different islands from the Aegean Sea of the genotypes belonging to *Nigella arvensis* complex, conducted to a speciation process (STRID, 1970). Also, through genetics processes (the chromosomes fusion or fission), it results the chromosome number modification and a speciation process (a mis-division process in *Nigella doerfleri*, analysed by STRID, 1968). After ZOHARY & HOPF (2000), archaeological evidence about the earliest cultivation of *Nigella sativa* 'is still scanty'. Seeds of black cumin were found in the tomb of Egyptian Pharaoh Tutankhamen, who ruled Egypt from 1333-1324 B.C. (the son of Akhenaton and Nefertiti), with the role to assist him in the afterlife. In the Bible, in the book of Isaiah in the Old Testament (Isaiah 28: 25, 27), it is described as the "curative black cumin". In Islam, the seed of *Nigella sativa* is regarded as one of the greatest forms of healing medicine available. Mohammed, Allah's Messenger said about *Nigella sativa* seed ~~as~~ that 'there is not disease for which *Nigella sativa* seed does not provide remedy' (RANDHAWA & AL-GHAMADI, 2002). The seeds have been traditionally used in the Middle East and Southeast Asia countries to treat ailments including asthma, bronchitis, rheumatism and related inflammatory diseases, to increase milk production in nursing mothers, to promote digestion and to fight parasitic infection, as well as against ~~to~~ scorpions and snake wounds. Moreover, the oil has been used to treat skin conditions, as eczema and boils, and to treat cold symptoms; it also has anticancer properties. Researches performed on cpDNA point out an evolutionary process in *Nigella arvensis* alliance from the Aegean Sea area (BITTKAU & COMES, 2005).

Allium sativum L. (garlic) is believed to originate from Central Asia (Kazakhstan, Uzbekistan, and western China), another centre of cultivated plant (MATHON, 1981). This hypothesis is confirmed by phylogenetic analysis based on molecular and biochemical markers, also indicating a secondary diversity centre in the Caucasus. Garlic spread to the Mediterranean area from the ancient times. The existence of two or three origin centres can be explained through its use by primitive human populations, who transported it in their migration: Africa-Middle East (and Mediterranean area) – Caucasus-Central Asia. Garlic spread in the Mediterranean area in ancient times. Also, garlic was grown in tropical Africa (being probably native in this geographical region), in Sahel, and at high elevations in East and southern Africa. Garlic was already grown in Egypt in 1600 BC and in ancient India and China.

Solanum tuberosum L. (potato) originates from a region of the Andes. In southern Peru, from a species in the *Solanum brevicaule* complex, where they were domesticated 7,000-10,000 years BC (SPOONER et al., 2005). Subsequently, following centuries of selective breeding, there are now over a thousand different types of potatoes. This region is also remarked through the presence of some evolved human civilizations. We must mention that in this region there were domesticated many others culture plants as: tomato, bean, tobacco, maize, cotton, cocoa, etc.

Equus ferus caballus (domestic horse). The earliest known member of the Equidae family was the ***Hyracotherium***, which lived between 45 and 55 million years ago, during the Eocene period. From this, it derived the ***Mesohippus***, which lived 32 to 37 million years ago. About 5 million years ago, the modern *Equus* evolved. The proto-horses changed from leaf-eating forest-dwellers to grass-eating inhabitants of semi-arid regions worldwide, including the steppes of Eurasia and the Great Plains of North America. About 15,000 years ago, *Equus ferus* was a widespread Holarctic species. Horse bones from this time period, the late Pleistocene, are found in Eurasia, Beringia, and North America. Yet between 10,000 and 7,600 years ago, the horse became extinct in North America and rare elsewhere, probably due to climate change. The Tarpan or European Wills Horse (*Equus ferrus ferrus*) was found in Europe and much in Asia. It survived in the historical era, but became extinct in 1909, when the last captive sample died in a Zoo Garden, in Russia. At present it was recreated the Tarpan, using horses with outward physical similarities. The only true wild horse alive today is the Przewalski's horse (*Equus ferus przewalskii*), a rare animal known also as the *Mongolian Wild Horse*, *taki* (Mongolian people), or *kirtag* (Kyrgyz people).

Canis familiaris (dog). Studies performed on the genetic distance for mitochondrial DNA on dog and Eurasian wolves (*Canis lupus*), confirmed that wolves represent the exclusive ancestor species to dog. The mitochondrial DNA analysis suggests four independent domestication events (VILA et al., 1997). Studies performed by different researchers, suggest different aspects. SAVOLAINEN et al. (2002) suggest a common origin from a single East Asian gene pool for all dog population, while 18 point to the Middle East as the source of most of the genetic diversity in the domestic dog, and a more likely origin of the domestication events (VAN HOLDT et al., 2010). PANG et al. (2009) in a study performed at the Kunming Institute of Zoology found that the domestic dog is descent from wolves tamed less than 16,300 years ago south of the Yangtze River in China. The domestication process of the wolf occurred through natural selection when Mesolithic human building permanent settlements in which a new ecological niche (middens and landfills) was opened by wolves. These wolves had a commensally relations with humans, feeding on their waste over many generations, with natural selection favouring assertive wolves with shorter flight distance in human presence, and causing physical changes related to the redundancy of features adapted for hunting big game. Although dogs are the most closely to grey wolves (the sequence divergence between they is about 1.8%), there are a number of physical and behavioural differences. Moreover, between different sorts of dogs there are also big differences.

Gallus domesticus (chicken). The domestic chicken ~~is~~ descended primarily from Red Jungle fowl (*Gallus gallus*), but some genes was incorporated into domestic birds through hybridization with the Grey Jungle fowl + (*Gallus sonneratti*; ERICKSON et al., 2008). A study performed by FUMIHITO et al. (1994) point out that it occurred a single domestication in the region of actual Thailand. Recent investigations performed by other authors (LIU et al, 2006; ZEDER et al., 2006), point to multiple material origins, with the clad found in the Americas, Europe, Middle East, and Africa, originating from the Indian peninsula, with a big number of unique heliotypes. The origin site of the chicken was probably in Southern China in 6,000 BC (WEST & ZHOU, 1988); it migrated on the Indus valley and Pakistan, very populated regions. In Romania, the chicken reached about 3,000 BC (KIPLE & ORNELAS, 2000). The research performed by SCHWEITZER (1993), SCHWEITZER et al. (1994), suggest that chickens are the closest living relative of *Tyrannosaurus rex*, as there are similarities in collagen fibres and proteins between the two species.

CONCLUSIONS

The recent paleontological data and researches of molecular genetics suggest the presence of four varieties of humans, among which it took place crossing, resulting viable hybrids.

The number of human forms is possible to be greater, based on the paleontological data from the Qesem cave (Israel), and the origin human to be in other geographical region.

In their migration and spread on the Earth surface, the humanoid groups spread also the domesticated plants and animals.

The genetic origin centres where the domestication process of plants and animals occurred, must present some characteristics: the human presence over an appreciable period time (probably over 10,000 years), an adequate size and optimal life conditions, a rich reserve of germ-plasma with a genetic variability, the human interest for their use, etc.

In Fertile Crescent, as well as in Central Asiatic Centre, there were met ancestors of the domesticated species, and many human populations belonging to different genotypes. They evolved together.

REFERENCES

BITTKAU C. & COMES P. 2005. *Evolutionary process in continental islands system: molecular phylogeography of the Aegean Nigella arvensis alliance (Ranunculaceae) inferred from chloroplast DNA.* Molecular Ecology, John Wiley ed., Vancouver, BC: **14**: 4065-4083.

BRUNET M. 2011. *In Sahelo-Saharian Africa on the track of a new cradle of mankind.* Acta Paleontologica Romaniae, Cluj University Press. **7**: 61-68.

COPPENS Y. 2011. *Il y eu plusieurs sorties d'Africa.* Sciences et Avenir. Multimédia, Paris. **779**: 58-60.

CORNEANU G., CORNEANU MIHAELA, BERCU R. 2004. *Comparison of some morpho-anatomical features at fossil vegetal species and their actual correspondent species.* Studia Universitatea „Babeş-Bolyai", Geologia. Cluj University Press, Cluj-Napoca. **49**(2): 77-84.

DENNIS C. & GALLANGHER R. (Eds.). 2001. *The human genome.* Nature/Palgrave, London. 140 pp.

ERIKSON J., LARSON G., GUNNARSON U., BED'HOM B., TIXIER-BOICHARD M. 2008. *Identification of yellow skin gene reveals a hybrid origin of the domestic chicken.* PLoS (Public Library of Science) Genetics, Jan. 23, 2008. Scripps Research Institute, La Jolla, CA

FUMIHITO A., MIYAKE T., SUMI S., TAKADA M., OHNO S., KONDO N. 1994. *One subspecies of the red junglefowl (Gallus gallus gallus) suffices as thye matriarchic ancestor of all domestic breeds.* PNAS (Peptide Nucleic Acid's). Proceedings National Academy of Science of USA, Washington **91**(26): 12505-12509.

KATSNELSON A. 2010. *New hominin found via mtDNA.* The Scientist, Elsevier. 2010-11-12.

KIPLE K. F. & ORNELAS K. C. 2000. *The Cambridge World History of Food.* Cambridge University Press. **1.** 1958 pp.

KRAUSE J., FU Q., GOOD J. M., VIOLA B., SHUNKOV M. V., DEREVIANKO A. P., PÄÄBO S. 2010. *The complete mitochondrial DNA genome of an unknown hominin from Southern Siberia.* Nature Publications Group. **464**(7290): 894-897.

KRINGS M., STONE A., SCHMITZ RW., KRAINITZKI H., STONEKING M., PÄÄBO S., 1997. *Neanderthal DNA sequences and the origin of modern humans.* The Cell. Oxford University Press, Oxford. **90**(1): 19-30.

LADIZINSKY G. 1998. *Plant evolution under domestication.* Kluver Academic Publishers, Dordrecht. 254 pp.

LIU Y.-P., WU G.-S., YAO Y.-G., MIAO Y.-W., LUIKART G., BAIG M., BEJA-PEREIRA A., DING Z.-L. 2006. *Multiple maternal origins of chickens: out of the Asian jungles.* Molecular Phylogenetics and Evolution. Elsevier. **38**(1): 12-19.

MATHON CL.-CH. 1981. *L'origine des plantes cultivées. Phytogéographie appliquée.* Masson, Paris. 182 pp.

ÖZKAN H., BRANDOLINI A., SCHÄFER-PREGL R., SALAMINI F. 2002. *AFLP analysis of a collection of tetraploid wheats indicates the origin of emmer and hard wheat domestication in Southeast Turkey.* Molecular Biology and Evolution. Oxford University Press, Oxford. **19**(10): 1797-1801.

PÄÄBO S., GREEN R.E., MARIČIC T., KRAUSE J., BRIGGS A., KELSO L., STENZEL U., VISAGIE J., AFFOURTIT J., SIMONS J. F., DU L., KNIGHT J., EGHOLM M., ROTHBERG J., BRAJKOVIĆ D., GUŠIĆ I., RUDAN P., KUĆAN Z., REICH D., PATTERSON N., MULLIKIN J., MALASPINAS S.-A., JOHNSON P., SLATKIN M. 2008. *Neandertal genomics.* XX International Congress of Genetics, Berlin: 9-10.

PANG J. F., KLUETSCH C., ZOU X. J., ZHANG A., LUO L. Y., ANGLEBY H., ARDALAN A., EGSTRÖM C., SKÖLERMO A., LUNDERBERG J., MATSUMURA S., LEITNER T., ZHANG Y.P., SAVOLAINEN P. 2009. *mtDNA data indicate a single origin for dogs south of Yangtze river, less than 16,300 years ago, from numerous wolves.* Molecular Biology and Evolution. Oxford University Press, Oxford. **26**: 2849-2864.

RANDHAWA M. A. & AL-GHAMADI M. S. 2002. *A review of the pharmaco-therapeutic effects of Nigella sativa.* Pakistan Journal of Medicine Researches. University Islamabad, Karachi, Pakistan. **41**(2): 1-14.

SAVOLAINEN P., ZHANG Y.-P., LUO J., LUNDEBERG J., LEITNER T. 2002. *Genetic evidence for an East Asian origin of domestic dogs.* Science. AAAS, High Wire Press. **298**(5598): 1610-1613.

SCHWEITZER M. H. 1993. *Biomolecule preservation in Thyranosaurus rex.* Journal of Vertebrate Paleontology. Smithsonian Institution Press, Washington. **13**: 56A.

SCHWEITZER M. H., CANO R. J., HOMER J. R. 1994. *Multiple lines of evidence for the preservation of collagen and other biomolecules in undemineralized bone from Thyranosaurus rex.* Journal of Vertebrate Paleontology. Smithsonian Institution Press, Washington. **14**: 45A.

SPOONER D. M., MCLEAN K., RAMSAY G., WAUGH R., BRYAN G. J. 2005. *A single domestication for potato based on multilocus amplified fragment length polymorphism.* Proceedings National Academy of Science USA. National Science Foundation, Yale University Press. **102**(41): 14694-14699.

STRID A. 1968. *Stable telocentric chromosomes formed by spontaneous misdivision in Nigella doerfleri (Ranunculaceae).* Botaniser Notiser. Springer Verlag, Heidelberg, Stuttgart, Berlin. **121**: 153-164.

STRID A. 1970. *Studies in the Aegean flora. XVI. Biosystematics of the Nigella arvensis complex, with the special reference to the problem of non-adaptative radiation.* Opera Botanica Lund. Societate botanica Lundensi, Sweden. **28.** 172 pp.

VAVILOV N. I. 1961. *Origin and geography of cultivated plants* (translated by Doris Löve). 1992. Cambridge University Press, Cambridge. **34**. 532 pp.

VILA C., SAVOLAINEN P., MALDONALDO J. E., RICE J. E., HONEYCUTT R. L. 1997. *Multiple and ancient origins of the domestic dog.* Science. AAAS, High Wire Press. **276** (5319): 1687.

VAN ZEIST W. A., BAKKER-HEERES J. A. H. 1992. *Archaeobotanical studies in the Levant. I. Neolithic sites in the Damascus basin: Aswad, Ghovaifé.* Ramid Palaeohistoria. **24**: 165-256.

VAN ZEIST W. A. 1984. *List of names of wild and cultivated cereals.* Bulletin of Summerian Agriculture. **1**: 8-16.

VAN HOLDT B. M., POLLINGER J. P., LOHMÜLLER K. E. 2010. *Genome-wide SNP and haplotype analyses reveal a rich history underlying dog domestication.* Nature. Nature Publ. Co., Macmillen Publ. Ltd. **464**(7290): 898-902.

WEST B. & ZHOU B. X. 1988. *Did chickens go north? New evidence for domestication.* Journal of Archaeology Science. Elsevier. **14**: 515-533.

WHITE T. D., ASFAW B., BEYENE Y., HEILE-SELASSIE Y., LEVOJEV C. O., SUWA G., WOLDE-GABRIEL G. 2009. *Ardipithecus ramidus and the paleobiology of early Hominids.* Sience. AAAS, High Wire Press. 326: 65-86.

ZEDER M.A., EMSHWILLER E., BRADLEY D.G., SMITH B. D. 2006. *Documentation domestication: the intersection of genetics and archaeology.* Trends in Genetics. Elsevier. **22**(3): 139-155.

ZOHARY D. & HOPF M. 2000. *Domestication of plants in the Old World. The origin and spreads of cultivated plants in West Asia, Europe and the Nile Valley.* Third Ed., Oxford University Press, Oxford. 328 pp.

Corneanu C. Gabriel
Craiova University, 13 A.I. Cuza Street,
200585-Craiova, Romania.
E-mail: gabicorneanu@yaqhoo.com

Corneanu Mihaela
University of Agricultural Sciences and Veterinary Medicine of Banat
Calea Aradului 119, 300364-Timisoara
E-mail: micorneanu@yahoo.com

Received: March 31, 2011
Acceped: August 29, 2011

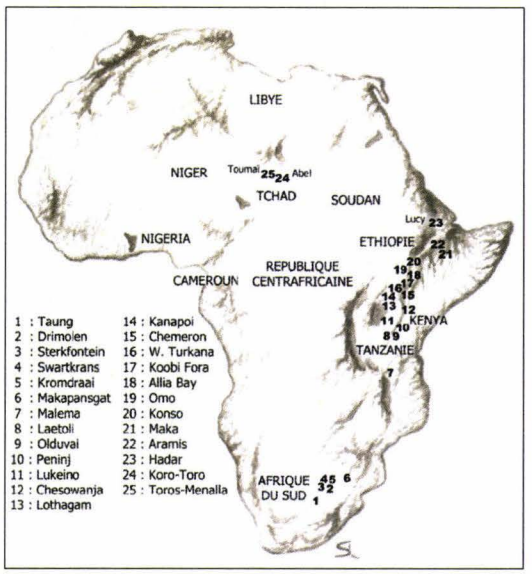


Figure 1. Archaeological locations in Africa (after Science et Vie, 2011).
Figura 1. Situsuri arheologice în Africa (după Science et Vie, 2011).

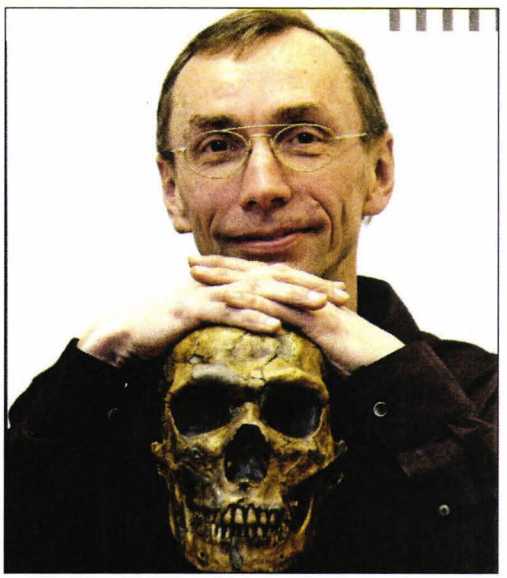


Figure. 2. Svante Pääbo with a Neanderthalian skull (after Science et Vie, 2011).
Figura 2. Svante Pääbo cu un craniu de Neanderthalian (după Science et Vie, 2011).

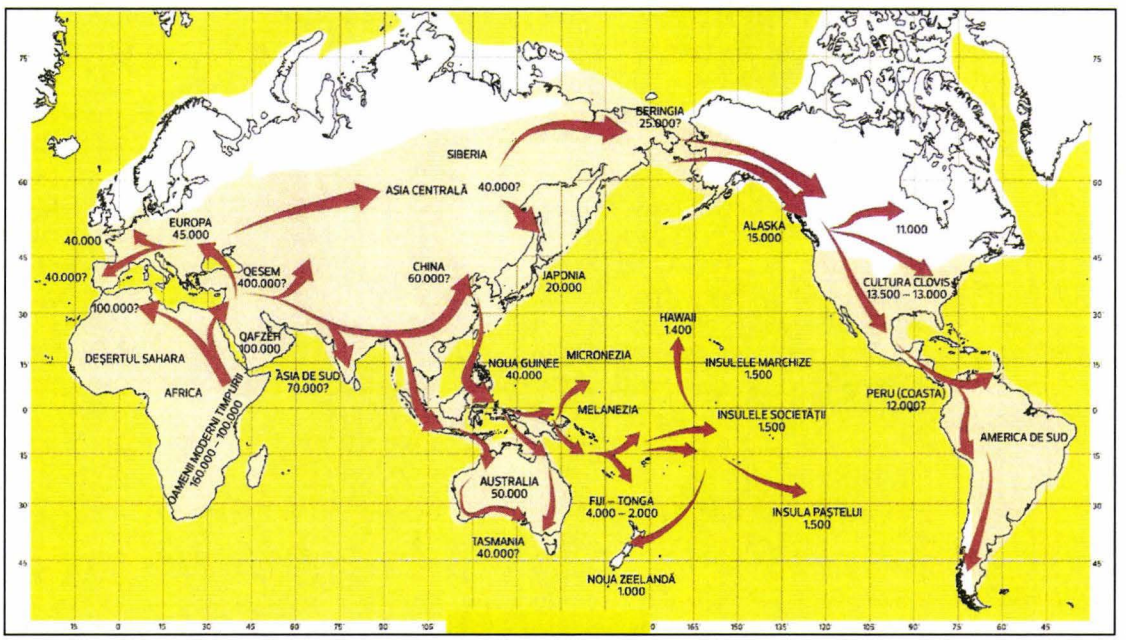


Figure. 3. Homo migration on the Earth surface (after Ştiinţă şi Tehnică, LX, **1**: 68, 2011).
Figura 3. Migraţia omului pe suprafaţa Pământului (după Ştiinţă şi Tehnică, LX, **1**: 68, 2011).

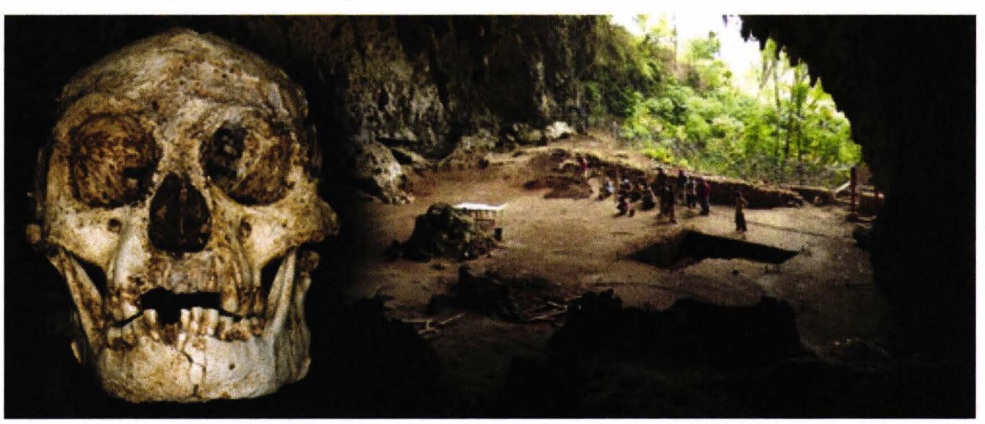


Figure 4. *Homo floresiensis* (after Science et Vie, 2011).
Figura 4. Homo *floresiensis* (după Science et Vie, 2011).

Figure 5. Differences between humane races (after Science et Vie, 2010).
Figura 5. Diferențe între rasele umane (după Science et Vie, 2010).

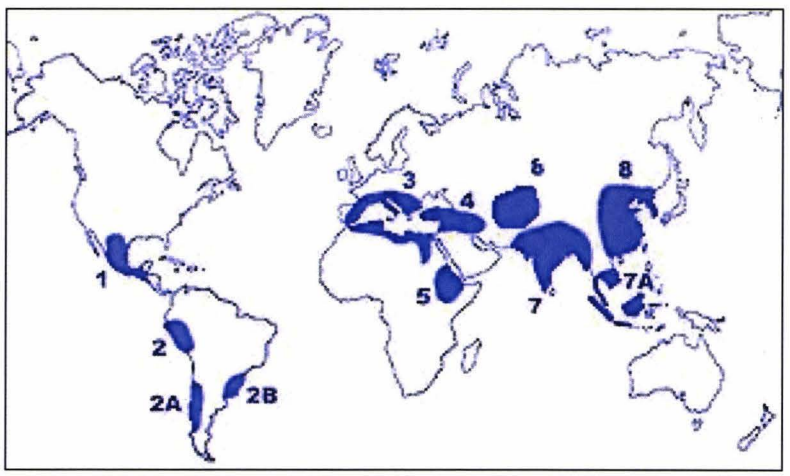


Figure 6. Center of plant origin (modified after LADIZINSKY, 1998). (1) Mexico-Guatemala, (2) Peru-Ecuador-Bolivia, (2A) Southern Chile, (2B) Southern Brazil, (3) Mediterranean, (4) Middle East, (5) Ethiopia, (6) Central Asia, (7) Indo-Burma, (7A) Siam-Malaya-Java, (8) China. / Figura 6. Centre de origine a plantelor (modificat, după LADIZINSKI, 1998).

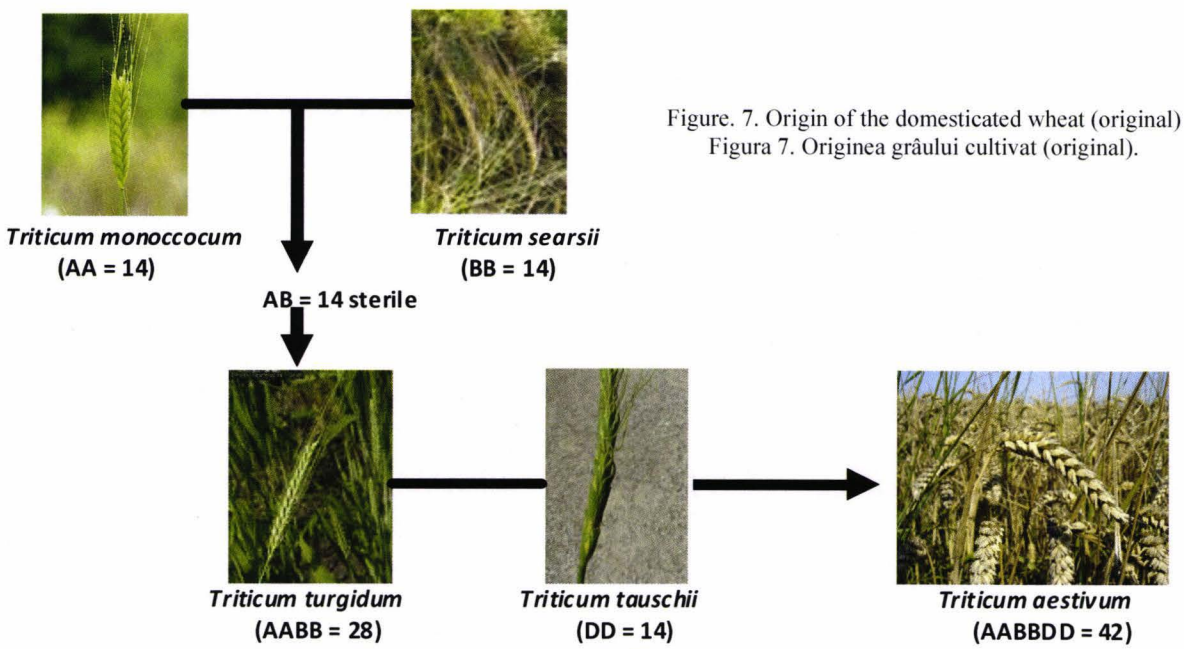


Figure. 7. Origin of the domesticated wheat (original)
Figura 7. Originea grâului cultivat (original).

RESEARCH FORERUNNERS IN THE FIELD OF AQUATIC ECOLOGY FROM ROMANIA

BREZEANU Gheorghe, CIOBOIU Olivia

Abstract. Research studies in the field of aquatic ecology (hydrobiology) from Romania are among the priorities of this science at European level. The founder of this field is Grigore Antipa. Contemporary and future researchers ensured the development of aquatic ecology in Romania – Ion Borcea, Emil Racoviţă, Constantin Motaş, Theodor Buşniţă, Mihai Băcescu, C. S. Antonescu, Nicolae Botnariuc. Besides them, future researchers' generations develop their forerunners' work.

Keywords: aquatic ecology, forerunners, Romania.

Rezumat. Precursori ai cercetării în domeniul ecologiei acvatice din România. Cercetările în domeniul ecologiei acvatice (hidrobiologiei) în România se înscriu între priorităţile acestei ştiinţe pe plan european. Fondatorul acestui domeniu este Grigore Antipa. Contemporani şi continuatori au asigurat dezvoltarea ecologiei acvatice în România: Ion Borcea, Emil Racoviţă, Constantin Motaş, Theodor Buşniţă, Mihai Băcescu, C. S. Antonescu, Nicolae Botnariuc. Alături de aceştia, generaţiile următoare de cercetători au preluat şi dezvoltă opera înaintaşilor.

Cuvinte cheie: ecologie acvatică, precursori, România.

In a previous volume of *Oltenia. Studies and communications. Nature Sciences*, it was widely analysed Grigore Antipa's activity and work (BREZEANU & CIOBOIU, 2010). He is the founder of modern hydrobiology, ecology from our country; he set up the theoretical and applicative basis of hydrobiology that brought to the development of this field. His work represented and continues to represent a reference point in assessing the stages that marked the knowledge of aquatic ecosystems structures and functions (ANTIPA, 1910, 1921, 1941; BÂRCA & BĂCESCU, 1969; MOTAŞ, 1961).

Referring to Antipa, it is fully justified the statement which underlines that "*Posterity, which is an implacable, but also impartial judge, assumed and developed his work through his capable successors. He remained a great scientist, a pioneer both at national and international level*" (NEGREA, 1990). This genuine truth was confirmed by the contemporary and future researchers' generations.

Ion Borcea (1879-1936), a passionate researcher in the field of marine biology, is considered the founder of oceanography in our country. His studies aimed at knowing the biology of the Black Sea (BĂCESCU, 1971).

As a professor of the University of Iaşi, he fought for setting up a marine research station. Due to his perseverance and efforts, he succeeded in overcoming the inertia of the administration system of the time, and, in 1926, he accomplished his dream and set up the first station of marine research at Agigea.

Agigea Research Station became an important study centre, greatly considered both in the country and abroad. As a station of the University "Al. I. Cuza" from Iaşi, year after year, their students perfected their studies together with numerous Romanian and foreign scientists.

Ion Borcea had remarkable results in the field of biology, his studies focussing on the Black Sea. He discovered and described more than 150 invertebrates and 90 fish species living in the Black Sea. He studied the anatomy and embryology of many fish species, their ecology, migration, reproduction and feeding aspects (BORCEA, 1930).

Among his most important works we mention: "*Crustacées Phyllopodes de Roumanie*", 1912; "*Faune survivante de type caspien dans les limans d'eau douce de Roumanie*", 1925; „*Fauna Mării Negre pe litoralul Dobrogei*", 1928; "*Observations sur les poissons migrateurs dans les eaus roumaines de la Mer Noire*", 1929; "*Nouvelles contributions a l'étude de la faune bentonique dans la Mer Noire, près du litoral roumaine*", 1931; "*Les clupeides de la région littorale roumaine de la Mer Noire des eaux intérieus*", 1936.

Emil Racoviţă (1868-1947) started his activity as an expert in the field of bio oceanography; his participation and contribution as a naturalist at the expedition in Antarctica, on the ship Belgica (1897-1899), is well-known. The scientific activity he devoted the rest of his life is biospeleology. He explored numerous caves in France where he set up the basis of biospeleology for the first time (RACOVITZA, 1907).

In 1920, when coming back to Romania, Emil Racoviţă set up the first Institute of Biospeleology in the world within the framework of the University of Cluj; he was the director of this institute between 1926 and 1939.

Racoviţă was also involved in setting up the international society called "Biospeologica"; he also published the journal with the same name. He led the exploration of more than 800 caves from Europe and Northern Africa; during these exploration studies, there were collected more than 20,000 samples on the basis of which there were published 41 memories in the series "Biospeologica" (RACOVIŢĂ, 1926, 1929, 1964, 1993). In Romania, in the period 1921-1931, he explored more than 150 caves in the Apuseni Mountains and 100 caves in the Southern Carpathians (ARDELEAN et al., 2000; RACOVIŢĂ et al., 2002).

Constantin Motaş (1891-1980) was a great personality of the Romanian science who left numerous fundamental works in the fields of zoology, limnology, hydrobiology, phreatobiology – a topic the basis of which was set up by him, oceanology, biospeleology (MOTAŞ, 2007).

In the field of hydrobiology, it is worth mentioning the monograph "*Hydrobiological research within the Bistriţa River basin*" published together with V. ANGELESCU in 1944 (MOTAŞ & ANGELESCU, 1944). It is a reference work for limnological research. We must also mention the work "*Limnological-piscicultural monograph of the Bistriţa River – Moldavia*" published together with V. ANGELESCU in 1939.

In order to emphasize the diversity of his scientific research, we mention "*Biology of the Black Sea*" (1928) and an important work of systematic zoology "*Contribution a la connaissance des Hydrocariens français, particulierement du Sud-Est de la France*".

Another remarkable work published in 1962 in collaboration with L. BOTOŞĂNEANU and ŞT. NEGREA, "*Research regarding the biology of springs and phreatic water from the central part of the Romanian Plain*", represents a real fundamental book in this scientific branch. Of course, the list of his works comprises many more titles – 527, which reflects his prodigious activity (MOTAŞ, 1962; MOTAŞ & ORGHIDAN, 1948; MOTAŞ et al., 1962, 1967; NEGREA et al., 2004).

He was a professor at the Zoology Department of the University of Iaşi and at the Faculty of Natural Sciences of the University of Bucharest, member of the Romanian Academy and director of the Institute of Speleology "Emil Racoviţă" from Bucharest between 1956 and 1963.

Theodor Buşniţă (1900-1977), Antipa's disciple and collaborator, is one of the personalities of the Romanian science that contributed to the development of hydrobiology and pisciculture. From his mentor, he inherited the rigor in organizing his scientific research and training in the field of fishing and pisciculture.

At his initiative, in 1953, it is set up the "*Commission of hydrobiology, hydrology, and ichthyology of the Romanian Academy*" that succeeded in reuniting a group of young researchers whose target was to develop the research of the aquatic bodies from our country. This commission represented a starting point for the future section of hydrology (oceanography and limnology) of the Biology Institute of the Romanian Academy. As leader of this section (1959-1970), he coordinated vast research programs regarding the hydrobiological study of the Danube, its floodplain, and the Danube Delta. Within this framework and under his direct coordination, it was elaborated the work "*Limnology of the Romanian Sector of the Danube*" (1967), considered a reference study of the Danube and the Danube Delta that analyses the physical-geographical features, limnology, and economic importance of the river, its floodplain, and delta.

In his first activity years, as a young researcher, he dedicated himself to the hystophysiological research of certain fish species. His results are mentioned in famous treatises. In the field of ichthyology, he brought original contributions to the creation of new carp breeds, the understanding of their behaviour, and study of the gynogenesis of the silver crucian carp.

The studies regarding the structural characteristics of fish populations from the Danube and other rivers are quite important as they define the specific zones in terms of ichthyofauna distribution (BUŞNIŢĂ, 1965, 1967a, b; BUŞNIŢĂ & ALEXANDRESCU, 1963).

Continuing Antipa's work, he set up the bases of the modern system of piscicultural exploitation – the passage from extensive to intensive, industrial pisciculture.

During his entire life, due to his skills and organizational talent, he held important functions: director of the State Fisheries, director of the Institute of Piscicultural Research, dean of the Faculty of Fishing and Pisciculture – the first such faculty in our country set up at his initiative, deputy director of the Biology Institute of the Romanian Academy and chief of the Section of Limnology and Oceanography.

Mihai Băcescu (1908-1999), a continuator of Grigore Antipa's work, can be considered the founder of modern oceanography in Romania. In 1958, he organized the oceanography section of the Romanian Academy. He and the researchers he guided developed a vast research program regarding the shelf of the Romanian sector of the Black Sea. He organized numerous expeditions and the results of their field and laboratory investigations are rendered in a great number of scientific studies published in four volumes of "*Marine Ecology*" (BĂCESCU, 1965, 1967; BĂCESCU et al., 1971).

His faunistic and taxonomic works comprised mainly studies regarding certain groups of marine and fresh water crustaceans; these papers were published in "*Fauna of Romania*". He had remarkable contributions to the knowledge of the biology and taxonomy of the crustaceans from the Indian Ocean, the Mediterranean Sea, the Atlantic Ocean, the seas neighbouring Australia and Latin America and this is only a part of his activity in the field. At the same time, he studied the rivers and lakes from our country (BĂCESCU, 1984). He continued the Grigore Antipa's museographic work as director of the museum with the same name.

C. S. Antonescu, a professor of hydrobiology at the Biology Faculty of the University of Bucharest, was also a researcher characterised by a great capacity of analysis and synthesis of the aquatic ecosystems (ANTONESCU & RUDESCU, 1958).

In his works regarding the water flora and fauna, he skilfully described plants and animals life. One of his most important works is "*Waters biology*" of more than 500 pages, where he minutely rendered life aspects from continental and marine water bodies (ANTONESCU, 1967).

Nicolae Botnariuc (1915 – 2011) contributed to the development of aquatic ecology and applied, for the first time in our country, the principle and conception of systemic analysis (BOTNARIUC, 1999, 2003; BOTNARIUC & VĂDINEANU, 1982).

He performed vast research studies aiming at the knowledge of the functional structures of the aquatic ecosystems from the Danube Delta and the river floodplain together with the teams he led at the Biology Institute of the Academy and at the Biology Faculty of the University of Bucharest (BOTNARIUC et al., 1964a, b).

The work "*Monograph of Crapina-Jijila pools complex*" (1961) published in collaboration with S. BELDESCU represents an important contribution to the establishment of the mechanisms that determine the production and productivity of such types of aquatic ecosystems. He underlined the role of the floods duration and period within the Danube Floodplain as an essential factor for the development of macrophytes and phytoplankton. In his work, he emphasized the role of light and water transparency upon aquatic life, underlining the importance of the rapport between transparency and depth, namely the transparency index (T/D) (BOTNARIUC & BELDESCU, 1961).

Analysing the development of hydrobiology in Romania, we may establish two representative stages – one stage belonging to Grigore Antipa and his contemporaries and the second post-war stage, when hydrobiological-ecological research knows a new development on the basis of former traditions.

REFERENCES

ANTIPA GR. 1910. *Regiunea inundabilă a Dunării. Starea ei actuală şi mijloace de a o pune în valoare.* Institutul de Arte Grafice Carol Gobi. Bucureşti. 138 pp.

ANTIPA GR. 1921. *Dunărea şi problemele ei ştiinţifice, economice şi politice.* Colecţia Studii şi cercetări. Academia Română. Bucureşti. **6**: 1-191.

ANTIPA GR. 1941. *Marea Neagră. 1. Oceanografia, bionomia şi biologia generală.* Academia Română. Publicaţia Fondului „Vasile Adamachi". Bucureşti. **10**(55): 1-313.

ANTONESCU C. S. 1967. *Biologia apelor.* Edit. Didactică şi Pedagogică. Bucureşti. 513 pp.

ANTONESCU C. S. & RUDESCU L. 1958. *Caracterizare hidrobiologică a apelor din Delta Dunării.* Hidrobiologia. Edit. Academiei Române. Bucureşti. **1**: 291-303.

ARDELEAN A., MOHAN GH., TIŢU H. 2000. *Dicţionarul biologilor români.* **1** (A-M). **2** (N-Z).Tipografia Mediagraf. Arad: 119, 877.

BÂRCA GH. & BĂCESCU M. 1969. *Grigore Antipa.* Edit. Ştiinţifică. Bucureşti. 150 pp.

BĂCESCU M. 1965. *Studii asupra variaţiei vieţii marine în zona litorală nisipoasă la nord de Constanţa.* Ecologie marină. Edit. Academiei Române. Bucureşti. **1**: 25-185.

BĂCESCU M. 1967. *Dinamica vieţii marine litorale în sectorul Mamaia în 1962-1965.* Ecologie marină. Edit. Academiei Române. Bucureşti. **2**: 15-175.

BĂCESCU M. 1971. *Profesorul Ion Borcea - un mare naturalist, părintele oceanografiei româneşti.* Studii şi comunicări. Muzeul Ştiinţelor Naturii. Bacău: 7-34.

BACESCU M. 1984. *Quelques observations sur la fauna bentonique du défilé roumain du Danube.* Annales Scientifiques de l'Université Jassy. **12**: 7-34.

BĂCESCU M., MULLER G. I., GOMOIU M. T. 1971. *Compoziţia calitativă a faunei bentale din Marea Neagră.* Ecologie marină. Edit. Academiei Române. Bucureşti. **4**: 112-358.

BORCEA I. 1930. *Observation sur les poissons migrateurs dans les eaux roumains de la Mer Noire.* Annales Scientifiques de l'Université Jassy. **15**: 656-750.

BOTNARIUC N. 1999. *Evoluţia sistemelor biologice supraindividuale.* Edit. Universităţii Bucureşti. **1**. 216 pp.

BOTNARIUC N. 2003. *Evoluţia sistemelor biologice supraindividuale.* Edit. Academiei Române. Bucureşti. **2**. 237 pp.

BOTNARIUC N. & BELDESCU ST. 1961. *Monografia complexului de bălţi Crapina-Jijila.* Hidrobiologia. **2.** Edit. Academiei Române. Bucureşti: 9-33.

BOTNARIUC N. & VĂDINEANU A. 1982. *Ecologie.* Edit. Didactică şi Pedagogică. Bucureşti. 438 pp.

BOTNARIUC N., BELDESCU ST., BOLDOR O. 1964a. *Producţia primară a apelor din zona inundabilă a Dunării I.* Hidrobiologia. Edit. Academiei Române. Bucureşti. **5**: 35-51.

BOTNARIUC N., NEGREA ALEXANDRINA, TUDORANCEA CL. 1964b. *Rolul moluştelor în economia complexului de bălţi Crapina-Jijila.* Hidrobiologia. Edit. Academiei Române. Bucureşti. **5**: 95-105.

BREZEANU GH. & CIOBOIU OLIVIA. 2010. *Grigore Antipa (1867-1944) the founder of ecological hydrobiology.* Oltenia. Studii şi comunicări. Ştiinţele Naturii. Muzeul Olteniei Craiova. **26**(2): 313-315.

BUŞNIŢĂ TH. 1965. *Probleme ecologice şi economice ale cegii din Dunărea de Jos.* Hidrobiologia. Edit. Academiei Române. Bucureşti. **6**: 3-17.

BUŞNIŢĂ TH. 1967a. *Die Bevolkerung der Donaustauseen mit Clupeonella delicatula (cultriventris).* Hidrobiologia. Edit. Academiei Române. Bucureşti. **8**: 125-131.

BUŞNIŢĂ TH. 1967b. *Die Ichtyofauna des Donaufflusses.* Limnologie der Donau. Stuttgard. **3**: 28-39.

BUŞNIŢĂ TH. & ALEXANDRESCU I. 1963. *Atlasul peştilor din apele R. P. R.* Edit. Ştiinţifică. Bucureşti. 250 pp.

MOTAŞ C. 1961. *Viaţa şi activitatea lui Grigore Antipa.* Biblioteca Academiei R.P.R. Seria de Bibliografii. Grigore Antipa (1867 – 1944). Edit. Academiei R.P.R. Bucureşti. **13**. 130 pp.

MOTAŞ C. 1962. *Procédés des sondages phreatiques. Division du domaine souterrain. Classification écologique des animaux souterraines. Le psammon.* Acta Museum Macedonica. Sciences Nature Scopje. **8**: 135-173.

MOTAŞ C. 2007. *Opere - Freatobiologie.* Rovimed Publishers. Bucureşti. **1**. 190 pp.

MOTAŞ C. & ANGELESCU V. 1944. *Cercetări hidrobiologice în bazinul râului Bistrița.* Monografia Institutului de Cercetări Piscicole Bucureşti: 23-54.

MOTAŞ C. & ORGHIDAN T. 1948. *Quelques Cladocères recueillis dans l'eau phreatique.* Notes Biologicae, Bucharest. **6** (1-2): 123-129.

MOTAŞ C., BOTOŞĂNEANU L., NEGREA ŞT. 1962. *Cercetări asupra biologiei izvoarelor şi apelor freatice din partea centrală a Câmpiei Române.* Edit. Academiei Române. Bucureşti. 366 pp.

MOTAŞ C., DECU V., BURGHELE A. 1967. *Sur l'association pariétale des grottes d'Olténie (Roumanie).* Annales Speleologie. Paris. **22**: 475-522.

NEGREA ŞT. 1990. *Pe urmele lui Grigore Antipa.* Edit. Sport Turism. Bucureşti: 1-263.

NEGREA ŞT., NEGREA ALEXANDRINA, ARDELEAN A. 2004. *Biodiversitatea în mediile subterane din România.* Vasile Goldiş University Press. Arad. 248 pp.

RACOVITZA E. G. 1907. *Essai sur les problèmes biospéologiques.* Archive Zoological Experimentale Generale. Biospeologica I. Munchen. **6**: 371-488.

RACOVIŢĂ E. 1926. *Speologia, discurs rostit la 13 iunie 1926 în şedinţa solemnă sub preşedenţia de onoare a M. S. Regelui.* Discursuri şi recepţiune. Academia Română. Bucureşti. **61**: 1-43.

RACOVIŢĂ E. 1929. *Evoluţia şi problemele ei.* Biblioteca Astra. Cluj. **6**. 183 pp.

RACOVIŢĂ E. 1964. *Opere alese.* Edit. Academiei R.P.R. Bucureşti. 813 pp.

RACOVIŢĂ E. 1993. *Cugetări evoluţioniste.* Edit. Academiei Române. Bucureşti. 813 pp.

RACOVIŢĂ GH., MOLDOVAN OANA, ONAC B. 2002. *Monografia carstului din Munţii Pădurea Craiului.* Edit. Presa Universitară Clujeană. Cluj-Napoca. 264 pp.

Brezeanu Gheorghe
Romanian Academy, Institute of Biology, Str. Splaiul Independenţei
No. 296, 060031, Bucharest, Romania
E-mail: aurelia.brezeanu@ibiol.ro

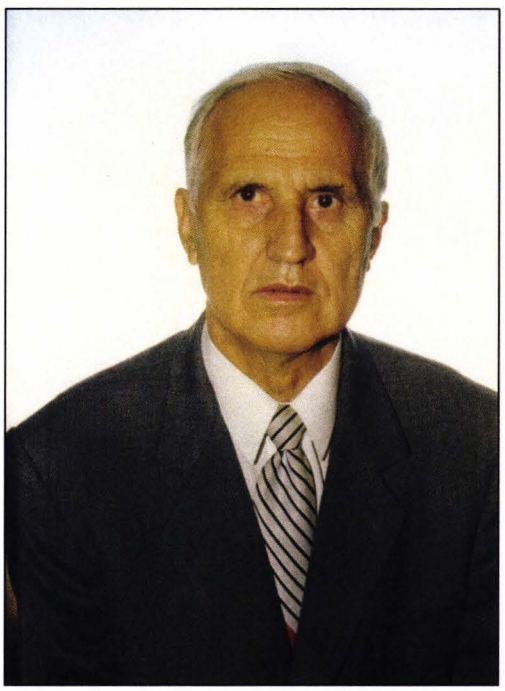
Cioboiu Olivia
The Oltenia Museum, Craiova, Str. Popa Şapcă
No. 8, 200422, Craiova, Romania
E-mail: cioboiuolivia@yahoo.com

Received: March 31, 2011
Accepted: August 28, 2011

IN MEMORIAM

UNIVERSITY PROFESSOR DOCTOR CONSTANTIN PISICĂ (1932-2011)

MUSTAŢĂ Gheorghe



Trees dye standing defying for a good period of time the laws of nature. So it was the leaving from life of the university professor Dr. Constantin Pisică. I met him Thursday morning (October 23, 2011) at the "George Georgescu" Institute of Cardiology within the Hospital "I. C. Parhon", where he had come to be hospitalized. I was preparing my things for discharge. Surprised by the meeting, I asked him: what happened? He guiltily smiled at me and told that he had angina pectoris during the night and could not sleep. But he was sad that he would not be able to go as a tourist to Sicily. He always proved a great vitality during the practical applications with the students, being unequally. We have discussed many issues, and among others, he was telling me with justifiable pride about the achievements of his son, George, as a doctor in France, Paris, and about her granddaughter, already a student at the Faculty of Pharmacy in the second year of study. Investigations had already begun, when we wished each other good health and left. The next day, I was going to learn that the professor has no longer got the sunset. He disappeared like a fire ball that lits the sky paths.

He was born on March 1st, 1932, in Merisani village, Dobroteşti Commune, Teleorman County, in a family of hard working peasants. He learned at the Primary school in the native village, then he attended the high school studies at Roşiorii de Vede, at the "Anastasescu" High School and he graduated in 1952. In the same year, he became a student of the Faculty of Natural Sciences from "Alexandru Ioan Cuza" University in Iaşi. Being in love with nature, in the first years of study, he took the eminent Professor Dr. Mihai Constantineanu, being conquered by his aureole of great entomologist and thus, he became a member of the Students Research Circle, Zoology of Invertebrates.

Here he began his apprenticeship in the field of scientific research. Being appreciated for his native intelligence, for his passion to knowledge of nature and for his great power of work, the young graduate became a teaching assistant in 1957 at the Department of Zoology led by Professor Mihai Constantineanu. He had to carry all his academic, teaching and scientific activity. He oriented himself in research towards the study of ichneumonids, being impressed by the great treaty of his magistrate dedicated to the knowledge of this family of parasitoids. He has accompanied the professor in all applications in the field, organized for the collecting of entomological material and especially ichneumonids. In 1969, he obtained his Dr. in biological sciences by defending his valuable Dr. thesis with the title: **"Contributions to the study of Pimplinae (Pimplinae Cresson, Hymenoptera, Ichneumonida"**. He was the first among the disciples of the professor, who would form the strongest school of Ichneumonology in Europe.

The systematic and faunal researches of the Ichneumonids were made on a rich entomological material collected from almost all over Romania (Dobrudgea, the Danube Delta, the Central Moldavian Plateau, Ceahlău, Rarău, Călimani, Retezat, Gutâi Mountains, etc.).

In the realized scientific applications, he managed to make an impressive collection of entomology, with ten of thousands of specimens of ichneumonids. In his research, Professor Constantin Pisică managed to publish seven monographs and over 120 papers in prestigious journals of speciality. His scientific papers have been requested and appreciated by some of the great ichneumonologists of the world, including J. Dubert - France, Dr. Casparian - Russia, C. Thirion - Belgium, R. Hinz - Germany, H. Townes - USA, etc.

The research activity carried out by the Professor Constantin Pisică included a wide range of problems: the study of Mallophaga and Anoplura parasiting on domestic and hunting birds, studies of biodiversity of entomophags, the different complexes of entomophags that control some populations of harmful insects.

Vast contract research studies have been conducted with different beneficiaries from Romania and abroad. During the 2000-2004 period, he worked on a research project funded by the European Commission - Fauna Europaea.

As a doctorate coordinator, he formed a total number of 22 doctors in biological sciences, particularly contributing to the development and raising the prestige of Entomological Science School from Iaşi.

As a university professor, he honoured the courses of Entomology, The Biology of Animal Pests, Invertebrates Zoology, Animal Phylogenesis, etc. His courses were permanently updated, being up to date with scientific information. The lectures were attractive, clear and synthetic, of a high scientific level. To come in the support of the students and specialists, the Professor has developed numerous university courses and manuals of practical works, alone or in collaboration: **Entomology, The Biology of Animal Pests, Invertebrates Zoology, etc.**

In the 1967-1968 period, he taught Zoology at a university in the Republic of Guineea and made an important collection of insects.

In the period 1990-1996, as Dean of the Faculty of Biology, he proved to be a good manager. He can be considered the founder of the Faculty of Biology in its modern structure. He had a meritorious contribution to the recovery of the biological research stations of the Faculty: **"Ioan Borcea" Marine Biological Station from Agigea and Salmonicol Station from Potoci-Neamț.**

As an acknowledgement of his academic activity, Professor Constantin Pisică received the Prize "Emil Racoviță" of the Romanian Academy for the research of ichneumonology and was a member of the National Council for attestation of Scientific Titles, University Diplomas and Certificates (1990-1996) and became a member of numerous scientific societies from Romania and abroad.

With regard to the man and professor Constantin Pisică, I met him at the first course in my life as a student, when he entered into the auditorium P 2 together with the Professor Mihai Constantineanu. Naturally, we asked ourselves, who are the ones who formed the academic suite of the professor.

Later, he would lead our biological practice organized at the "Stejarul" Biological Station in Pangarati for two years. With him I performed the biological practice on the bottom of the present Lake of Accumulation "Izvorul Muntelui" from Bicaz. Also, we visited together the tunnel of the hydro-electric station and the castle of equilibrium and attended to the closing of the dam from Bicaz. He was close to us and guided us with professionalism and attention in the knowledge of the world of insects. At that time, I met the first ichneumonids and he told us about the scientific work of our Professor Mihai Constantineanu.

Although I had not suspect as a student, my fate destined and directed me towards the Zoology of Invertebrates and I was employed as a teaching assistant at Professor Mihai Constantineanu after graduation, in 1962. Thus, we have become colleagues and joined in the School of Entomology initiated by the titan of the Romanian Zoology, university professor dr., Ioan Borcea, and founded by one of the greatest ichneumonologists of the time, Professor dr. Mihai Constantineanu. In these circumstances, I knew the colleague Constantin Pisică better.

I participated together with other disciples of the professor to remarkable and matchless entomological expeditions organized by our master to the Slătioara Secular Forest, at Baia Mare and Gutâi Mountains, to the "Iron Gates" and on the Isle of Ada-Kaleh, in ecosystems that passed into history, such as those from the Iron Gates and the Isle of Ada-Kaleh, which were covered by the reservoir from "The Iron Gates". We were together at my first practical application, organized with the students, in 1963, to the Retezat Mountains. It was the most beautiful practice and Professor Constantin Pisică showed all his valences as an organizer and entomologist. Such expeditions now belong to the history of science, as the research results were published in various scientific journals and in major treaties of ichneumonology, which appeared in the series the Fauna of Romania.

At that time, you were not obliged to publish in the so - called I.S.I. journals, but the ichneumonology treaties of Professor Mihai Constantineanu and of his disciples were demanded all over the scientific world, although they were written in the Romanian language. Professor Constantin Pisică proved to be the most faithful and most prolific member of the Romanian School of Ichneumonology, even if he made research on Malophaga and Anoplura too. The results of his work honour him and place him in the gallery of the great ichneumologists of Europe.

As I have already mentioned, Professor Pisică honoured the courses of Entomology, Biology of Animal Pests and Zoology of Invertebrates, masterly contributing to the formation of dozens of generations of biologists.

Now, at the final parting, his valences as researcher, university Professor and good colleague appear to me in more vivid colours. His intelligence, qualities of researcher and university professor were aligned with his open, honest, and sociable character.

He has worked with passion and commitment until the last days of his existence and has achieved an academic opera of excellence that will last in time.

Professor Constantin Pisică had a substantial contribution to the development of the biological education and to the development of the powerful School of Entomology from Iași, from Romania, from Europe.

Professor Constantin Pisică is no longer with us, but he will remain present among us through his didactic and scientific work and through the vigour of the branch started from his genealogical tree.

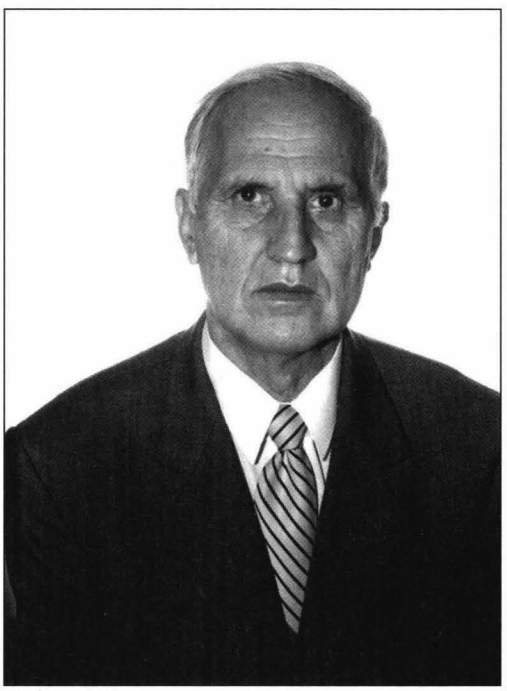
Gheorghe Mustață
Titular Member of the Academy of Scientists from Romania
"Alexandru Ioan Cuza" University, Faculty of Biology
Bd. Carol I, 20 A, 700506 Iași, Romania
E-mail: mustata_ghe@yahoo.com

Received: Octomber 19, 2011
Accepted: November 2, 2011

IN MEMORIAM

PROFESOR UNIVERSITAR DOCTOR CONSTANTIN PISICĂ (1932-2011)

MUSTAŢĂ Gheorghe



Arborii mor în picioare sfidând pentru o bună perioadă de timp legile naturii. Aşa a fost plecarea din viaţă a prof. dr. Constantin Pisică. L-am întâlnit joi dimineaţa (23 octombrie 2011) la Institutul de Cardiologie „George Georgescu" din cadrul Spitalului „I. C. Parhon", unde venise să se interneze. Eu îmi pregăteam lucrurile pentru externare. Surprins de întâlnire l-am întrebat ce s-a întâmplat. Mi-a zâmbit vinovat şi mi-a spus că are angină pectorală şi că în timpul nopţii nu a putut dormi. Era însă supărat că nu mai putea merge ca turist în Sicilia. Totdeauna a dovedit o vitalitate deosebită, în timpul aplicaţiilor practice cu studenţii fiind de neegalat. Am discutat multe probleme, iar între altele îmi spunea, cu justificată mândrie despre realizările fiului său George ca medic în Franţa, la Paris şi despre nepoata sa, deja studentă la Farmacie în anul al doilea. Ne-am urat sănătate şi ne-am despărţit, deja începuse investigaţiile. A doua zi aveam să aflu că profesorul nu a mai apucat asfinţitul soarelui. S-a stins asemenea unui bolid care luminează cărările cerului.

S-a născut la 1 martie 1932 în satul Merişani din comuna Dobroteşti, judeţul Teleorman, într-o familie de ţărani gospodari. A urmat şcoala primară în satul natal, apoi studiile liceale la Roşiorii de Vede, la Liceul „Anastasescu", devenind absolvent în 1952. In acelaşi an a devenit student al Facultăţii de Ştiinţe Naturale de la Universitatea „Alexandru Ioan Cuza" din Iaşi. Fiind îndrăgostit de natură s-a apropiat din primii ani de eminentul prof.dr. Mihai Constantineanu, fiind cucerit de aureola sa de mare entomolog, devenind astfel membru al Cercului Studenţesc de Cercetare Zoologia nevertebratelor. Aici şi-a început ucenicia în domeniul cercetării ştiinţifice. Fiind apreciat pentru inteligenţa sa nativă, pentru pasiunea faţă de cunoaşterea naturii şi pentru marea sa putere de muncă, tânărul absolvent a devenit în 1957 preparator la Catedra de Zoologie condusă de profesorul Mihai Constantineanu. Aici avea să-şi desfăşoare întreaga activitate academică, didactică şi ştiinţifică. În cercetare s-a orientat către studiul ichneumonidelor, impresionat fiind de marele tratat al magistrului său dedicat cunoaşterii acestei familii de parazitoizi. L-a însoţit pe profesor în toate aplicaţiile de teren organizate pentru colectarea de material entomologic şi în special de ichneumonide. În 1969, avea să devină doctor în ştiinţe biologice prin susţinerea valoroasei teze de doctorat: **„Contribuţii la studiul pimplinelor (Pimplinae Cresson, Hymenoptera, Ichneumonidae)".** A fost primul dintre discipolii profesorului, care aveau să formeze cea mai puternică şcoală de ichneumonologie din Europa.

Cercetările de sistematică şi de faunistică a ichneumonidelor au fost făcute pe un bogat material entomologic colectat din aproape toată ţara (Dobrogea, Delta Dunării, Podişul Central Moldovenesc, munţii Ceahlău, Rarău, Călimani, Retezat, Gutâi etc).

În aplicaţiile ştiinţifice efectuate a reuşit să realizeze o impresionantă colecţie de entomologie, cu zeci de mii de exemplare de ichneumonide.

În cercetările sale, profesorul Constantin Pisică a reuşit să publice 7 monografii şi peste 120 de articole în prestigioase reviste de specialitate. Lucrările sale au fost solicitate şi apreciate de unii dintre marii ichneumonologi ai lumii, între care J. Dubert - Franţa, Dr. Casparian - Rusia, C. Thirion - Belgia, R. Hinz - Germania, H. Townes - SUA ş.a.

Activitatea de cercetare desfăşurată de profesorul Constantin Pisică a cuprins un spectru larg de probleme: studiul Malophagelor şi al Anoplurelor parazite pe păsările domestice şi de vânat, studii de biodiversitate ale entomofagilor, complexele diferite de entomofagi care controlează unele populaţii de insecte dăunătoare. Ample cercetări contractuale au fost efectuate cu diferiţi beneficiari din ţară şi din străinătate. În perioada 2000-2004 a lucrat la un proiect de cercetare finanţat de Comisia Europeană - Fauna Europaea.

În calitate de conducător de doctorat a format un număr de 22 de doctori în ştiinţe biologice, contribuind în mod deosebit la dezvoltarea şi ridicarea prestigiului Şcolii Entomologice de la Iaşi.

în calitate de cadru didactic universitar a onorat cursurile de Entomologie, Biologia dăunătorilor animali, Zoologia nevertebratelor, Filogeneză animală etc.

Cursurile sale erau permanent actualizate, fiind la zi cu informarea ştiinţifică. Prelegerile erau atractive, clare şi sintetice, de un înalt nivel ştiinţific.

Pentru a veni în sprijinul studenților și al specialiștilor, profesorul a elaborat numeroase cursuri universitare și manuale de lucrări practice, singur sau în colaborare: **Entomologie, Biologia dăunătorilor animali, Zoologia nevertebratelor** etc.

În perioada 1967-1968 a predat Zoologia la o universitate din Republica Guineea și a făcut și o importantă colecție de insecte.

În perioada anilor 1990-1996, în calitate de decan al Facultății de Biologie s-a dovedit a fi un bun manager. Poate fi considerat ctitorul Facultății de Biologie în structura sa modernă. A avut o contribuție meritorie la recuperarea unor stațiuni de cercetare biologică ale Facultății: **Stațiunea Biologică Marină „Ioan Borcea" de** la Agigea și **Stațiunea Salmonicolă de la Potoci - Neamț.**

Ca o recunoaștere a activității sale academice profesorul Constantin Pisică a primit Premiul „Emil Racoviță" al Academiei Române pentru cercetările de ichneumonologie și a făcut parte din Consiliul Național de Atestare a Titlurilor Științifice, Diplomelor și Certificatelor Universitare (1990-1996) și a devenit membru a numeroase Societăți Științifice din țară și din străinătate.

În ceea ce privește omul și profesorul Constantin Pisică l-am cunoscut de la primul curs din viața mea de student, când a intrat în amfiteatrul P 2 împreună cu profesorul Mihai Constantineanu. Ne-am întrebat, în mod firesc, cine sunt cei care formau suita academică a profesorului. Mai târziu, avea să ne conducă, timp de doi ani, practica biologică organizată la Stațiunea „Stejarul" de la Pângărați. El ne-a purtat în practică pe rundul actualului lac de acumulare „Izvorul Muntelui" de la Bicaz, cu el am vizitat tunelul hidrocentralei și castelul de echilibru și tot cu el am participat la închiderea barajului de la Bicaz. Era apropiat de noi și ne îndruma cu profesionalism și cu atenție în cunoașterea lumii insectelor. Atunci am cunoscut primele ichneumonide și ne-a vorbit despre opera științifică a profesorului nostru Mihai Constantineanu.

Deși nu bănuiam, ca student, soarta m-a hărăzit și m-a canalizat către Zoologia nevertebratelor, fiind încadrat după absolvire, în 1962, ca preparator la profesorul Mihai Constantineanu. Astfel, am devenit colegi și ne-am încadrat în Școala de Entomologie inițiată de titanul Zoologie românești, Prof. univ. dr. Ioan Borcea și fundamentată de unul dintre cei mai mari ichneumonologi ai timpului, Prof. dr. Mihai Constantineanu. În aceste împrejurări, aveam să-l cunosc mai bine pe colegul Constantin Pisică.

Am participat împreună și cu alți discipoli ai profesorului la remarcabilele și inegalabilele expediții entomologice organizate de magistrul nostru la Codrul Secular Slătioara, la Baia Mare și Munții Gutâi, la Porțile de Fier și pe insula Ada-Kaleh, în ecosisteme care au trecut în istorie, fiind acoperite de apele lacului de acumulare de la Porțile de Fier. Am fost împreună la prima mea aplicație practică organizată cu studenții, în 1963, în munții Retezat. A fost cea mai frumoasă practică, iar profesorul Constantin Pisică și-a arătat toate valențele de organizator și de entomolog. Astfel de expediții, țin acum de istoria științei, rezultatele cercetărilor fiind publicate în diferite reviste științifice și în marile tratate de ichneumonologie apărute în seria Fauna României.

Atunci nu erai obligat să publici în revistele așa-numite I.S.I., însă tratatele de ichneumonologie ale profesorului Mihai Constantineanu și ale discipolilor săi erau căutate pe toate meridianele lumii științifice, deși erau scrise în limba română.

Profesorul Constantin Pisică s-a dovedit a fi cel mai fidel și cel mai fecund membru al Școlii românești de ichneumonologie, chiar dacă a făcut cercetări și asupra Malofagelor și Anoplurelor. Rezultatele muncii sale îl onorează și îl așează în galeria marilor ichneumonologi ai Europei.

Așa cum am mai prezentat, a onorat cursurile de Entomologie, Biologia dăunătorilor animali și Zoologia nevertebratelor, contribuind în mod magistral la formarea a zeci de generații de biologi.

Acum, la despărțirea definitivă, îmi apar în culori mai vii valențele sale de cercetător, de profesor universitar și de bun coleg. Inteligența, calitățile sale de cercetător și de profesor universitar, se armonizau cu caracterul său deschis, sincer și sociabil.

A muncit cu pasiune și dăruire până în ultimele zile ale existenței sale și a realizat o operă academică de excelență, care va dăinui în timp.

Profesorul Constantin Pisică a avut o contribuție substanțială la dezvoltarea învățământului biologic și la dezvoltarea puternicei Școli de Entomologie de la Iași din România și din Europa.

Profesorul Constantin Pisică a plecat dintre noi; el va rămâne însă prezent între noi prin opera sa didactică și științifică și prin vigoarea ramului pornit din arborele său genealogic.

Gheorghe Mustață
Membru titular al Academiei Oamenilor de Știință
Universitatea "Alexandru Ioan Cuza", Facultatea de Biologie
Str. Bd. Carol I, nr. 20 A, 700506 Iași, România
E-mail: mustata_ghe@yahoo.com

Received: Octomber 19, 2011
Accepted: November 2, 2011

RECOMMENDATIONS
regarding the elaboration of the papers for the scientific journal
"Oltenia. Studii şi comunicări. Ştiinţele Naturii"

The journal is edited by the Oltenia Museum Craiova and it publishes original papers in the fields of vegetal and animal biology, ecology-environment protection, mineralogy-paleontology, as well as scientific reports, reviews, anniversary or commemoration papers. It appears annually, accredited by CNCSIS as a B+ Journal and content indexing BDI, Zoological Record link la ISI Master Journal List: http://science.thomsonreuters.com/cgi-bin/jrnlst/jlresults.cgi?PC=MASTER&Word=oltenia.

I. Structure, format:

A. Original papers will be structured according to information rendered in the next table:

Table

STRUCTURE OF THE PAPER	CHARACTERISTICS	OBSERVATIONS
TITLE	Capital letters, 12 pt., bold, centered	
two spare rows (12 pt.) between the title and the name of the author/s		
Author/Authors	name, capital letters, first name, non capital, 11 pt., bold, normal, aligned right	between two or many authors, use comma
One spare row, 10 pt.		
Abstract (English)	from the beginning of the line, without tab, 9 pt., bold, normal	the abstract will be written with 9 pt., normal, maximum 300 words
One spare row, 9 pt.		
Keywords (English)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
One spare row, 9 pt.		
Rezumat (Romanian)	from the beginning of the line, without tab, 9 pt., bold, normal	**Complete translation of the title in Romanian** (no capital letters, except for the first letter of the title; 10 pt., bold). The content of the abstract – 9 pt., normal, maximum 300 words
One spare row, 9 pt.		
Cuvinte cheie (Romanian)	from the beginning of the line, without tab, maximum 5 words, 9 pt., normal	
One spare row, 14 pt.		
INTRODUCTION	10 pt. (capital letters, bold)	content – 10 pt., normal
One spare row, 10 pt.		
MATERIAL AND METHODS	10 pt. (capital letter, bold)	content – 10 pt., normal
One spare row, 10 pt.		
RESULTS	10 pt. (capital letter, bold)	content – 10 pt., normal
One spare row, 10 pt.		
DISCUSSIONS	10 pt. (capital letter, bold)	content – 10 pt., normal
One spare row, 10 pt.		
CONCLUSIONS	10 pt. (capital letter, bold)	content – 10 pt., normal
One spare row, 10 pt.		
ACKNOWLEDGEMENTS	10 pt. (capital letter, bold)	content – 10 pt., normal
One spare row, 10 pt.		
REFERENCES	10 pt. (capital letter, bold)	content – see bibliographical references
One spare row, 10 pt.		
Bibliography enumeration	see the detailed explanations at the references heading	
Personal data	Name and surname – 8 pt., bold, normal, centered Institution and e-mail address – 8 pt., normal, centered	

B. Scientific reports will be structured according to the author's (authors') preferences, but it has to include abstract and key words, both in English and Romanian.

C. As for reviews, there will be mentioned: author (authors) of the book (name and first name – SMALL CAPS), comma, the title of the book, non capitals (*Italic*), publishing house, publishing location, year, number of pages. Use a free space and then render the text of the review with as fewer paragraphs as possible and the same characters as in the case of original papers.

- **the materials sent** for publication (printed and in electronic format) has to be between 2 and 8 pages (the number of pages must be even);
- **publishing language:** English;
- **page format** – A4 (21 x 29.7 cm), margins: top – 2.5 cm; bottom – 2.0 cm; left – 2.0 cm; right – 2.0 cm; gutter – 0 cm; header, footer – 1.27 cm. The papers will be elaborated in Microsoft Word, justified; font: Times New Roman, 10 pt., normal; single space;
- latin names (genus, subgenus, species, subspecies) will be written with *italic characters*; **suprageneric names are not written** with italic characters. The same procedure is used when they are mentioned within figures, graphs and tables;
- you have to use the English punctuation signs, namely comma instead of dot and dot instead of comma at numbers in the text, figures, and tables. For example: 54,30 m (in Romanian) = 54.30 m (in English); 2.500 m (in Romanian) = 2,500 m (in English);
- the first mention of a taxon in the text will be followed by the taxon author's name and the publishing year of the description, according to the zoological nomenclature code (e.g.: *Cossus cossus* (LINNAEUS 1758);
- the names of the authors quoted in the text, at references, as well as the authors of the scientific names will be written in SMALL CAPS; **if you do not know** this option, **write normally, not capital letters!**

II. References

➢ **References** in the text (quotation) includes only the author's/authors' names (SMALL CAPS) and publishing year.

Example: IONESCU (1965), STEFĂNESCU, 2008a or (IONESCU, 1965; STEFĂNESCU, 2008a), when it is a single author; IONESCU & WEINBERG (1970), RĂDULESCU & SAMSON (1990) or (IONESCU & WEINBERG, 1970; RĂDULESCU & SAMSON, 1990), when there are two authors; IONESCU et al. (1992) or (IONESCU et al., 1992), when there are more than two authors;

- in case there are many papers written by the same author/authors, published in the same year, use the letters a, b, c etc. after the year (e.g.: IONESCU, 2000; IONESCU, 2000a, …, 2000g).

➢ **References** will include **only** the papers quoted in the text (10 pt.), alphabetically rendered, without numbers, as it follows: author (SMALL CAPS), publishing year (normal), (**do not use** comma between the author and the publishing year or between the name and first name of the same author; use comma between different authors, when there are more than two), *the title of the paper* (*italic*), name of the journal, publishing house, volume number (bold), the number of fascicle (normal), number of pages (normal). When there are two authors, use "**&**"; if there are many authors, mention **all** of them. The ladies' first name is completely written; for gentlemen, use only the first letter. The reference titles will be aligned as it follows: the first line from the beginning (no tab), the second at 1.27. Example:

Book reference:

BOŞCAIU N. 1971. *Flora şi vegetaţia Munţilor Ţarcu, Godeanu şi Cernei.* Edit. Academiei R.S.R., Bucureşti: 30-35.

Paper published in a journal:

STAN MELANIA & BACAL SVETLANA 2006. *New contributions to knowledge of Staphylinidae (Coleoptera: Staphylinidae) of the landscape reserve "Codrii Tigheci" (Moldova).* Oltenia. Studii şi comunicări. Ştiinţele Naturii. Muzeul Olteniei Craiova. **22**: 155-159.

Reference to a part of a collective paper; volume (with editors):

IFTIME AL. 2005. *Amfibieni şi Reptile.* In: Botnariuc & Tatole (Eds.) Cartea Roşie a Vertebratelor din România. Edit. Academiei. Române: 1-325.

Papers presented at scientific manifestations and published in a volume without editors:

CIOCHIA V. & STANCĂ-MOISE CRISTINA 2001. *Contributions to the knowledge of the Macrolepidoptera from natural complex "Dumbrava Sibiului".* Sesiunea Ştiinţifică dedicată împlinirii a 75 de ani de la înfiinţarea Staţiunii Biologice Marine "Prof. dr. I. Borcea" Agigea-Constanţa. 19-20 octombrie 2001: 125-131.

Official publications (laws, decrees, official reports):

*** România. *Legea nr. 13 / 1993 pentru aderarea României la Convenţia privind conservarea vieţii sălbatice şi a habitatelor naturale din Europa, adoptată la Berna la 19 septembrie 1979.* Monitorul Oficial al României, An. V, nr. 62/25 martie 1993. Bucuresti: 1-20.

Ph.D thesis: COSTACHE I. 2005. *Flora and vegetation Motru River Lower Basin.* Ph.D. Thesis, University of Bucharest: Romania. 290 pp., 8 Pl.

Web page: Muzeul Olteniei Craiova. Secţia Ştiinţele Naturii. *Oltenia. Studii şi comunicări. Ştiinţele Naturii* (online). 2008. Publisher: Museum of Oltenia Craiova. Romania. http://olteniastudii.3x.ro/. (accessed: May 8, 2011).

Entire electronic document or service (data base, e-book):

Fauna Europaea: *Chironomidae.* In: Fauna Europaea: Chironomidae, Diptera, Nemathocera (ed. H. de Jong). Fauna Europaea version 1.5, http://www.faunaeur.org. (accessed: June 23, 2011).

For e-book:

CARROLL L. 1994. *Alices Adventures in Wonderland* (online). Texinfo ed.2.1. (Dortmund, Germany): WindSpiel, November 1994 (cited 30 March 1995). Chapter VII: A Mad Tea-Party. Available from the World Wide Web: http: www germany.eu.net/books/caroll//alice_10.html#SEC 13 (accessed: March 30, 1995).

Electronic publication (papers):

DANILEVSKY M. L. 2007. *A check-list of Longicorn Beetles (Coleoptera, Cerambycoidea) of Europe.* Available online at: http://www.coleoptera-literatura.ic.cz./literatura/checklist_cerambycidae_2007.doc. (accessed: May 20, 2011).

Note: The papers published with other characters than the **Latin** ones, **will be re-written with Latin characters,** both in text and at references.

Example: ALEXANDROVICH O. R. 1995. *Reconstruction of the ways of the ground beetles (Coleoptera, Carabidae) fauna forming at the West of the Russian plain.* In: I.K. Lopatin, Pisanenko A.D., Shklyarov L.P. (Editors), Fauna and taxonomy: Proceed. Zoology Museum Byel. University Minsk: Nauka I Tekhnika. **1:** 52-68. [In Russian with English abstract]

III. Illustration:

Images (white/black or colour) are inserted into the manuscript, but the original versions have to be also sent separately: original drawing made in ink, good contrast photographs, electronic images in TIFF format at a minimum resolution of 300 dpi.

➢ Tables and graphs will be inserted into the manuscript, but original versions will be sent separately, as well. Tables have to be achieved using the same text editor mentioned above, 8 pt. Graphs must be achieved in Microsoft Word or Microsoft Excel. The table' s legend will be written under the table, 8 pt., normal.

➢ Illustrations references (tables, images) will be made in the text as it follows: (Fig. 1), (Figs. 1a, b), (Figs. 3; 5); (Table 1); to the photos, the source or the photo' s author will be mentioned.

➢ The title of a figure (both in English and Romanian), will be centered below the figure; as for tables, put it above (aligned right), both 9 pt., normal. Examples:

a) Table 1. List of the identified staphylinids from the Lower Dniester. / Tabel 1. Lista faunistică a stafilinidelor identificate în pădurile Nistrului Inferior.

b) Figure 1. Distribution of the butterfly *Papilio machaon* L. / Figura 1. Distribuţia fluturelui *Papilio machaon* L.

➢ **For diagrams, use white, black, grey, different tones and hatches. They will not be published in colours.**

➢ Diacritical marks will be used for the Romanian authors and towns.

The paper will be accepted for publishing if:

➢ it acquires a favourable review from the scientific reviewers of the journal;

➢ it respects the aforementioned requirements;

➢ it is sustained within the framework of the International Conference "*Museum and scientific research*", organized annually in September;

➢ the publication fee is paid;

➢ it is respected the deadline, **March 31** of the current year.

The editorial board has the right to reduce the number of figures and photos (if there are too many as compared to the text of the paper or if they do not correspond to the requirements) and not to accept papers sent after deadline, **March 31, 2012.**

➢ **With all the respect for the authors, papers that do not correspond to the recommendations will be sent back.**

➢ **The responsibility of the scientific content of the papers depends entirely on the authors.** Authors must revise the papers reviewed by the reviewers.

The editorial board

ISSN 1454 – 6914

Tipar DeGrafo CRAIOVA ADV